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ART. XIII.—*On the Appalachian Mountain System;* by ARNOLD GUYOT, Professor in the College of New Jersey, Princeton. With a map.

THE remark has been made with justice that the Appalachian or Alleghany system of mountains, although situated in the midst of a civilized, nation is still one of the chains concerning which we have the least amount of positive knowledge. This is especially true respecting the height of the culminating points of different portions of the system. A great number of measurements, have indeed been made within the last thirty years, for the construction of railroads and canals and for other practical purposes, but this net-work of surveys, it is easy to understand, has included only the basis of the system, and the lowest points at which it may be crossed. Everything not connected with practical objects has received but little attention. True, a certain number of barometrical measurements were made a long time ago, chiefly in the north; they have not, however, proved to be exact when compared with the measurements which I have lately made with greater care and under more favorable circumstances. But we must not attribute the rarity and the imperfection of mountain measurements wholly to a want of interest in science or to the absolute preponderance of the utilitarian spirit which characterizes America. It is due, in a considerable degree, to the difficulty, which has existed until within a very few years, of procuring good instruments, and to the obstacles, often very great, which the explorer meets in these wild

regions. A chain of thirteen hundred miles in length is a vast field, especially when it includes mountains covered with interminable forests, where a footpath rarely guides the traveller's step, and which it is impossible to cross except with a hatchet in the hand and with a loss of time and strength often quite disproportionate to the results which are obtained. Add to this, that in many parts of the system, the journey is to be made in an unknown region, without a reliable map, far from a human dwelling, rarely penetrated by the most hardy hunters. The explorer must be ready to march without any trusty guide, and to sleep in the open air, exposed to the inclement temperature of the elevated regions, and obliged to depend for nourishment on the food which he can carry with him. In these circumstances the danger of perishing from exhaustion is by no means imaginary, as I know by experience.

In a great portion of the Appalachian chain, especially toward the south, the lofty forests which crown nearly all the summits, and the thick underbrush, literally impenetrable, of Rhododendrons and other evergreens, in which the faint track of the bear is often the only assistance of the traveller, are not less serious obstacles. The difficulty of obtaining general views enabling one to take his bearings in the labyrinth of mountains which cover the country, is thus considerably increased; and the favorable points of observation which are necessary to determine the position of the peaks which are measured or to be measured, and for identifying them in every case are by no means numerous. Besides all this, if the relative height of different culminating points has been determined correctly, there still remains, in order to fix their absolute height, the difficulty of determining the altitude of the points of departure or of the lower stations which are often hundreds of miles from the sea coast.

These various difficulties, or at least some of them, have diminished within the last ten years. Excellent barometers are now made in America and are within the reach of any willing observer. The railroad surveys cross all the principal sections and furnish a great number of points whose altitude is sufficiently determined to serve as a point of departure for measuring the summits throughout nearly the whole extent of the system. Moreover hypsometrical tables adapted to all the barometrical scales, partly compiled and partly computed by the writer, have been published by the Smithsonian Institution, and relieve the observer of the most tedious and time-consuming portion of his task, by reducing the computation of barometrical heights to the simplest arithmetical operation. These tables can be found in the volume of "Meteorological and Physical Tables" which, by the liberality of the Institution, is now accessible to every scientific man.

One of my first labors, on arriving in America, in 1848, was to collect all the measurements of the Appalachian system which had then been published. Except the elevations determined for railroads and canals, nearly all the more remarkable heights which had been measured were in New England or New York, that is to say, in the White, Green and Adirondack mountains. Add to this the secondary heights measured, in considerable number, in Maine, New Hampshire and Massachusetts, a few points in Pennsylvania and Virginia, and some rather vague determinations in North Carolina, by Dr. Mitchell, and we have nearly all the hypsometrical wealth then at the service of the geographer. Massachusetts, the only state in the Union which has had a regular trigonometric survey, furnished besides some geodetic points determined with great accuracy. The same may be said of the admirable work of the Coast Survey still progressing under the skillful direction of Prof. A. D. Bache; but the points geodetically measured are seldom distant from the coast. All the other altitudes which were published had been obtained by barometric measurement.

The comparison of these last soon led me to see in the heights published by different authors such differences as indicated either a confusion of names, or errors in measurement too considerable to be attributed to the formulas employed in calculating, and which could only be attributed to imperfect instruments, or to circumstances too unfavorable for the work which was undertaken. As for detecting the error, when there was a disagreement, it was hopeless; for, since most of the authors gave merely their results, without the observations from which they were deduced, and without describing the instruments employed, or the circumstances of the measurement, a discriminating criticism was impossible. Moreover, the measurements which I had occasion to verify were nearly all found to be affected by errors more or less considerable. I was therefore led to regard them all only as approximations which by no means superseded the necessity of new determinations.

Since 1849, I have devoted my summer excursions to a study of the physical configuration of the Appalachian system, and to the barometric measurement of those points which were most important in the establishment of the laws of its relief. I began with the most remarkable culminating groups, namely, the White Mountains, where I made four excursions in as many different summers, the Green Mountains and the Adirondack. I afterwards visited in three excursions the central and southern portions of Virginia, and the vast group of elevated chains which covers the western part of North Carolina, between the boundaries of Tennessee, Georgia and South Carolina, and which form, as my observations fully show, the culminating region of the whole Appalachian system.

I intend to continue these explorations, so far as circumstances permit, in order to collect sufficient facts for forming a just idea of the normal proportions of the system in all its parts. Meanwhile I present the list of results already obtained, hoping that this preliminary publication will afford some interest to scientific men. At the same time I desire to have it considered as a *resumé* merely of special memoirs in which I shall give the original measurements, and shall indicate the details of the work and the method employed for deducing these results. It is my wish to do my part toward establishing an usage which should be invariable among men of science, to give the elements on which are based the results, which should be in the common treasure of our knowledge. This would furnish to sound criticism the means of determining their proper value. In this particular case, however, such details may be more fitly placed in the transactions of scientific societies.

I present the following altitudes with some degree of confidence. An acquaintance of more than twenty years with the barometer, and the thousands of measurements which I have made in the Alps and elsewhere, have long ago initiated me into the theoretical and practical difficulties of the barometric method and of the instrument itself. In all measurements I have had a double object. I desired not only to obtain an accurate result, but also to perfect the barometric method. I hope I have been able to eliminate some errors and uncertainties which too commonly affect its working, and tend to throw upon the method a degree of distrust which should rather rest upon the observers themselves. At another time I may offer some further remarks upon this subject. At present I will only add that the value of the coëfficients in the formula of Laplace must be slightly modified, in accordance with the more recent determinations of the physical data which it employs, and that the corrections which depend upon the temperature and the hour of the day in which the observations are made, deserve a much closer degree of attention than has hitherto been accorded to them.

In the volume of Physical and Meteorological Tables, published by the Smithsonian Institution, I have mentioned two instances in which my barometric measurements were followed the next year by leveling with a spirit level. This occurred in the two culminating points of the Appalachian system, Mount Washington in the White Mountains of New Hampshire, and the summit of the Black Mountains in North Carolina. The received height of Mount Washington had previously been 6226 feet. My measurements in 1851 gave 6291 feet. The measurements by spirit level, by U. A. Godwin, Civil Engineer, in 1852, gave 6285 feet, and a similar leveling under the direction of the Coast Survey in 1853, gave a height of 6293 feet.

For the Black Dome of North Carolina, the culminating point of the Black Mountains, (lately called also Mitchell's High Peak, but not the former Mount Mitchell,) my measurements in 1856 gave 6702 feet, or, by adopting the modification of the coëfficient just alluded to, 6707 feet. A measurement by spirit level in the following year, 1857, by Major J. C. Turner, Civil Engineer, who had my figures in his hand, and who set out from my point of departure, gave an altitude of 6711 feet.

To these coincidences I may add examples still more recent. Waynesville, the chief town in Haywood County, North Carolina, 27 miles from Asheville, being one of my principal stations for the measurement of all the culminating region of the Appalachian System, I determined its altitude with care by a series of hourly correspondent observations extending through several days, one at Asheville, the other at Warm Springs, thirty-seven miles below the French Broad river, near the boundary of Tennessee, the altitudes of these two points being given by the Survey of the Charleston and Cincinnati railroad which follows the valley of the French Broad, beyond the mouth of the Swannanoa. The Asheville series, in 1859, gave for the altitude of the base of the Waynesville Court House 2756 feet, assuming 2250 feet for the altitude of the Asheville Court House, according to a leveling which I was told had been executed between that point and the railroad track near the bridge of the Swannanoa. This figure of 2756 feet is that which I published early in July, 1860, in an Asheville newspaper. If I adopt the mean of the barometric measurements which I made for determining the elevation of Asheville, I find it to be 2246 feet, and Waynesville becomes 2752 feet. The series of 1860, which began at one of the benches of the railroad at Warm Springs, and which includes an intermediate station at Finescreek, gives also for Waynesville 2752 feet. But Col. Robert Love, of Waynesville, informs me that the altitude of this same point, as given to him by the Engineers of the Western North Carolina railroad, (who had just finished the location of that road,) was also 2752 feet.

I owe to the courtesy of Mr. Presstman, chief assistant of Maj. Jas. C. Turner, Chief Engineer of the road, a communication of the altitude of two other points also included in the list of published elevations, already mentioned, to wit, the summit of the route which crosses the Balsam chain at the upper end of Scott's creek, and the confluence of this creek with the Tuckaseege, twenty miles from Waynesville. In both cases, the railroad levelings agreed within a yard with the barometric measurements, these last being the highest.

These measurements, entirely independent, and proceeding from the same given points, present an argument which is well fitted to inspire confidence in barometric results obtained with fitting precautions.

I scarcely need to add that I cannot pretend to guarantee a similar degree of accuracy in the greater number of heights measured which rest upon a single observation. All those who are acquainted with the hypsometric method fully know that, in the determinations obtained, either by the theodolite, or by the barometer, accuracy is only secured by repetitions so numerous as to permit the elimination of accidental errors incident to the variable state of the atmosphere. I may say, however, that I have taken especial precautions to avoid the two principal causes of error in barometric measurements; namely, the unequal variation, both in time and quantity, of the atmospheric pressure in the corresponding barometers, and again, the errors in the determination of the true mean temperature of the air, at the hour of observation, whether by day or by night. To prevent the first I have taken a special care to locate the corresponding barometers at stations generally distant much less than twenty, and rarely exceeding thirty miles from the points measured. As to the second, when it was not possible to eliminate the errors due to the temperature of the air, by combining observations taken both by day and by night to produce a compensation, I have resorted to the aid of tables formed from a great number of experiments to be mentioned hereafter.

That which induces me to believe that the results resting on a single observation also deserve a good degree of confidence is that having had occasion to repeat the measurement of a great number of points previously determined by careful observations, both in the Black mountains and in the county of Haywood, in different years and under different conditions of the atmosphere, the new results did not differ from those previously obtained by more than one to three yards. When the height of a mountain is known within these limits of approximation the claims of physical geography may be regarded as satisfied.

The barometers which I have employed in these different measurements are a series of Fortin barometers, modified by Delcros, and manufactured by Ernst, at Paris. These instruments, with the exception of one which is my own property, have been imported by myself under the authority of the Smithsonian Institution, for the purpose of determining by direct comparison, the relation between the standard barometer of the observatory at Paris, and the standard barometer intended for the Institution. They have been kindly left at my disposal by the Secretary, for the prosecution of these hypsometrical researches.

These instruments have been compared with the utmost care, not only before and after each excursion, but also during the progress of each, whenever there has been an opportunity. The corresponding observations have always been made with one or the other of the barometers thus compared, and their relative corrections, resulting from the equations thus established, have

always been applied in the calculations. A long familiarity with Gay Lussac's syphon barometer, with Bunten's improvement, as well as with Fortin's cistern barometer, modified by Ernst, has convinced me that the latter is to be preferred, notwithstanding its weight and its greater length, if the utmost accuracy compatible with the method is to be sought. The variations of capillary attraction, and the soiling of the tube of the short branch of the syphon by the oxyd of mercury in the Bunten barometer are serious inconveniences. The impossibility of repairing such barometers in case they are injured in travelling, is a still more serious difficulty. I carry with each of my Fortin barometers, two extra tubes and a bottle of purified mercury which enable me in case of accident to reconstruct my barometer in two hours time, even in the depths of the wildest forest. This advantage is of the utmost value in America where every explorer must trust to himself and his own resources, unless he is willing to be constantly deprived of his instruments. It is difficult for me to think coolly of so many scientific expeditions, sent at great expense into unexplored countries, in which observations, even if made with an inferior instrument, would have had great value, but in which all barometric measurements became impossible by the fracture of the instrument at the outset of the journey. Such an excuse, under the ordinary circumstances, of an official expedition, is quite inadmissible.

Such were the considerations which led me to introduce in this country and especially recommend the modified Fortin barometer, when in 1849, '50, '51, I was charged with establishing, in the states of New York and Massachusetts, fifty meteorological stations under the scientific direction of the Smithsonian Institution. Acting in its behalf I superintended the construction of a series of meteorological instruments of which the manufacture was entrusted to a skillful optician, Mr. James Green, of New York, and which are now extensively employed throughout the United States, under the name of the Smithsonian Meteorological Instruments. I especially endeavored to render these instruments strong, simple and adjustable. By the latter phrase, I mean that their construction allows them to be regulated by a standard instrument so as to eliminate the error of zero in the thermometer, and in the barometer the total error due to capillarity and to the peculiarities in the construction of each instrument, so that they will all give immediately absolute values conformed to the same standard, and consequently comparable with one another. In the thermometer it is enough to suspend the tube to the scale by means of a screw, which permits the tube to be moved along the scale until the zero of the mercury coincides with that of the scale. In the barometer I obtain this result by means of a moveable scale which slides upon the brass casing

of the barometric tube and which is so placed as to make its indications accord with those of the normal barometer. A line traced on the fixed scale marks the natural height of the column of mercury and makes apparent the value of the applied correction.

Each instrument made by Green, bearing a fixed number, and having been carefully compared with the standard (such, at least is the direction given) its indications may be immediately compared with those of any other of the same maker. This adjustment is evidently important for stationary observations, for it dispenses with the task of reducing by an applied correction each series of observations to a standard scale. For travelling observers and for the measurements of heights the scale of adjustments becomes of no account since it is enough to compare carefully with one another, the barometers which are employed, and to determine their equations, which otherwise are liable to vary and ought to be constantly observed anew. It is consequently better to dispense with the moveable scale, which may be disarranged by the accidents incident to a journey.

After many different experiments, and at the suggestion of Mr. Green, the cistern was modified, and instead of the two parts of the cistern screwing upon each other, a system which occasioned frequent leakage of the mercury, a means of closure by planes of contact was substituted, which not only make leakage impossible, but permit the opening and dismounting of all the parts of the cistern at any time, with the utmost ease. This construction is not only stronger, but it greatly facilitates the cleansing of the mercury, which it is well to attend to frequently. Finally it dispenses with cement and as the cistern is of injected box wood, the evil effects of extreme temperatures and of extreme moisture and dryness are avoided. Barometers of this construction are now in use throughout America, having been substituted for those of Bunten in the army meteorological stations, and having been employed in the numerous expeditions of the Pacific railroad surveys. I accordingly consider the introduction of these instruments at an epoch, when for various reasons, scientific researches were so rapidly increasing in America, as a very fortunate circumstance in enhancing the value of these same observations; for I may add that previous to this epoch, with the exception of a very few instruments imported from Europe, I scarcely found in the hands of the observers in this country a single barometer which had a scientific value.

The preceding details will not be void of interest to those who have occasion to make use of the observations recently made in America in official and other explorations. As for my own observations I would mention that they have been constantly accompanied by corresponding observations made by my young

friends who have attended me in the various excursions, and who have studied under my direction the use of the barometer. I ought particularly to mention Mr. Ernest Sandoz, who has been with me in nearly all my excursions, and Mr. Emile Grand Pierre, who was my companion during three summers. I have also received the kind assistance of Dr. Bache, the Superintendant of the Coast Survey, who caused a series of corresponding observations for the measurement of Mt. Washington in 1851, to be made by two of his assistants, Messrs. Edward Goodfellow and B. F. West.

I would also mention Dr. Algernon Coolidge, who accompanied me to the Green Mountains, and to whom I owe, in addition to corresponding observations, the measurement of the Camel Hump. My young friends, Alexander Agassiz, Edward Rutledge, and Herbert Torrey, have given me active coöperation in the White Mountains. To my friend and fellow traveller in the Black Mountains, Rev. W. H. Green, of Princeton, I owe a number of corresponding barometric observations, and likewise a number to Prof. W. C. Kerr, of Davidson College, and to Mr. W. A. Benners, of Waynesville.

The corresponding observations, made by my companions in travel, were taken hour by hour, and sometimes even once every quarter of an hour, so as to allow the construction of a complete barometric curve which represents with great exactness the state of the barometer for any hour of the day, and renders the error of interpolation almost null.

For the purpose of distinguishing accurately the relative position of the regions explored, it may be well to describe the general structure of the system of mountains to which they belong.

The upheavals of ancient rocks which constitute this well connected physical structure, for which, as a whole, it is proper to retain the common name of the Appalachian system, extend in an undulating line thirteen hundred miles in a mean direction of N.E. to S.W., from the promontory of Gaspé upon the Gulf of St. Lawrence to Alabama, where the terminal chains sink down and are lost in the recent and almost horizontal strata of the cretaceous and tertiary formations which cover the greater portion of the surface of this state. This long range of elevations is composed of a considerable number of chains, sensibly parallel to each other, occupying more particularly the eastern part which faces the ocean, and of an extended plateau which prevails towards the west and northwest and descends gradually towards the inland valleys of the St. Lawrence, the lakes Erie and Ontario and the Ohio river.

The base on which this large belt of mountains rests, and which may be considered as bounded by the Atlantic Ocean on one side and by the Ohio and St. Lawrence rivers on the other,

is formed, in the east, by a plain slightly inclined towards the Atlantic. The width of that plain, in New England, does not vary much from fifty miles. Near the mouth of the Hudson, however, in New Jersey, it nearly disappears, but gradually increases towards the south to a width of over two hundred miles. Its elevation above the sea, at the foot of the mountains, is in New England, from 300 to 500 feet. From the neighborhood of the bay of New York, where it is nearly on a level with the ocean, it rises gradually towards the south to an altitude of over 1000 feet. On the west the table-lands which border upon the Ohio River, and which may be considered as the general base of the system, preserve a mass-elevation of a thousand feet or more, in the thickness of which the river-bed is scooped out to the depth of from 400 to 600 feet, thus reducing the altitude of the Ohio River full one-half from that of the surrounding lands.

The vast belt of the Appalachian highlands forms the marginal barrier of the American continent on the Atlantic side, and determines the general direction of the coast line, which in general, runs parallel to the inflections of its chains with remarkable regularity. This system, composed of a series of corrugations tolerably uniform, does not, like the Alps, or the other great systems of fracture, have a central or main axis, to which the secondary chains are subordinated. But it is properly compared to the system of the Jura, for it is composed like that of a series of long folds, or chains, which run parallel to each other, often with great regularity. In the same part of the system the general height of the chains is sensibly equal and their summits show neither many nor deep notches. In the middle region, especially in Pennsylvania and New Jersey, they present the appearance of long and continuous walls, the blue summits of which trace along the horizon a uniform line seldom varied by any peaks or crags. In the extreme northern and southern portions, however, this character is considerably modified. There the system loses very much of its uniformity and its physical structure becomes far more complicated; the form of simple parallel ridges almost entirely disappears.

There is one feature of the Appalachian system which distinguishes it from the ranges of the Jura; it is the well marked division into two longitudinal zones of elevation, one turned towards the shores of the Atlantic, in which the form of parallel chains just spoken of predominates, and the other turned towards the interior, which is composed of elevated and continuous plateaus, descending from the summit of their eastern escarpment, in the centre of the system, in gentle stages towards the basins of the lakes and the valley of the Ohio. Occasionally minor chains, very little elevated from their base, wrinkle the surface of the table lands. Their parallelism with those of the eastern mountainous

zone shows that they are but the last undulations due to the action of the same forces which have upheaved and folded that region, and which have raised at the same time, the mass of these more uniform plateaus. Thus when from any point we traverse the Appalachian system from the Atlantic, we encounter first a plain more and more undulated and gradually ascending to the foot of the mountains; then a mountainous zone with its ranges parallel and its valleys longitudinal; at length a third zone of uniform plateaus slightly inclined towards the northwest, and cut with deep transverse valleys.

Another feature not less conspicuous characterizes the region of corrugations properly so-called. This is a large central valley which passes through the entire system from north to south, forming, as it were, a negative axis through its entire length. This is what Mr. Rogers calls the Great Appalachian valley. At the north it is occupied by lake Champlain and the Hudson river; in Pennsylvania it bears the name of Kittatinny or Cumberland valley. In Virginia it is the Great valley; more to the south it is called the valley of East Tennessee. At the northeast and at the centre its average breadth is fifteen miles; it contracts in breadth towards the south, in Virginia, but reaches its greatest dimensions in Tennessee where it measures from fifty to sixty miles in breadth. The chain, more or less compound, which borders this great valley towards the southeast is the more continuous and extends without any great interruption from Vermont to Alabama. In Vermont it bears the name of Green Mountains, which it retains to the borders of New York; in the latter State it becomes the Highlands; in Pennsylvania the South Mountains; in Virginia the Blue Ridge; in North Carolina and Tennessee the Iron, Smoky, and Unaka Mountains. On the northwest of the great valley between the latter and the borders of the plateau parallel there extends a middle zone of chains separated by narrow valleys, the more continuous of which is the range which bounds the central valley. This zone has a variable breadth in different parts of the system, and the number of chains which compose it is by no means uniform throughout.

Although these features are common to the Appalachian system throughout its entire length, nevertheless it may be divided from north to south into three *divisions* which present very remarkable differences of structure. Passing the eye over the physical chart which accompanies this article we at once distinguish in the longitudinal extent of the Appalachian system two principal curvatures, the one at the north from Gaspé to New York, the concavity of which is turned towards the southeast; the other at the centre, from the Hudson to New River in Virginia, with its concavity also towards the southeast; the third from New

River to the southwest extremity of the system, the direction of which is nearly straight or forming a gentle curve concave towards the northwest. These three divisions, diminishing in extent, from the north to the south, are well marked, at the north, by the deep valleys of the Mohawk and the Hudson, which break through the Appalachian system to its base and across its entire breadth; at the south, by the New River whose deep valley with vertical walls also separates regions whose orographic characters present remarkable differences.

The *northern division* is much the most isolated; it is geologically the most ancient, since its upheavals appear coeval with the Silurian and Devonian epochs, and are thus much anterior to the rest of the system, which only emerged after the deposit of the carboniferous rocks which it has elevated. Four hundred feet more of water would separate all the vast territory of the northern division from the American continent. One hundred and forty feet would convert into an island all New England and the British possessions as far as Gaspé; for the bottom of the valley occupied by Lake Champlain and the Hudson does not in any part exceed this level.

I distinguish in this northern portion three physical regions; 1st, the triangular plateau of the Adirondack, with its mountain chains more or less parallel, between Lake Champlain and the St. Lawrence, Lake Ontario and the Mohawk: 2nd, New England, with the two swells of land separated by the deep valley of the Connecticut, and forming the base of the Green and White mountains: 3rd, the northern region, with the prolongation, towards the northeast, of the same features of relief, from the source of the Connecticut through Maine into Canada and New Brunswick to the promontory of Gaspé and the bay of Chaleurs.

The *middle or central division* extends in length about 450 miles. The eastern region, or region of folded chains, at first very narrow about New York, presents towards the centre, in Pennsylvania, its greatest breadth which again diminishes towards the south. It is composed of a considerable number of chains much curved towards the west, and remarkable for their regularity, their parallelism, their abrupt acclivities, the almost complete uniformity of their summits, and their moderate elevation, both relative and absolute, which varies from 800 and 1500 to 2500 feet. The chains, however, increase in elevation towards the south, while they become more numerous and more indented. In the Peaks of Otter, in Virginia, they attain to 4000 feet.

The western region, or the region of plateaus, is quite narrow in the southern part, but acquires towards the north the greatest breadth which it attains in any part of the Appalachian system. Its high terraces occupy all the State of New York south of the Mohawk, and a considerable part of Pennsylvania and culminate

in the plateaus in the neighborhood of Lake Erie, where the mean altitude of the plateau reaches 2000 feet, the valleys preserving a height of 1500 feet while the hills reach 2600 feet.

This tableland forms a remarkable water-shed from which the waters descend by the Susquehanna into the valley of the Chesapeake and the Atlantic ocean, by the Genesee and St. Lawrence to the same ocean, and by the Alleghany and Ohio to the Gulf of Mexico. The Susquehanna thus starts from Lake Erie at the extreme western border of the plateau, and runs across all the Appalachian system and its mountain ranges to its eastern base. More to the southward the eastern escarpment of the plateau divides, as far as the sources of the Potomac, the waters of the Atlantic coast from those of the Gulf of Mexico. It is the same escarpment which bears the local name of Alleghany Mountain, a name which continues to be applied, south of the waters of the Potomac, to the dividing ridge along the sources of the various branches of James River, and even to the irregular hills which form a water-shed between the waters of the upper Roanoke and New River, across the Great Valley, near Christiansburg. Through all this middle region the name of Blue Ridge is applied to the main eastern chain which separates the Great valley from the Atlantic slope, and which is cut by all the rivers which flow out of it.

The *southern division*, from New River to the extremity of the system, is much the most remarkable for the diversity of its physical structure and its general altitude. Even the base upon which the mountains repose is considerably elevated. Although the elevation of the Atlantic plain at the eastern base of the mountains is only 100 to 300 feet in Pennsylvania, and 500 in Virginia near James river, it is 1000 to 1200 feet in the region of the sources of the Catawba. In the interior of the mountain region the deepest valleys retain an altitude of 2000 to 2700 feet.

From the dividing line in the neighborhood of Christiansburg and the great bend of New River the orographic and hydrographic relations undergo a considerable modification. The direction of the principal parts of the system is also somewhat changed. The main chain which borders the Great valley on the east, and which more to the north, under the name of the Blue Ridge, separates it from the Atlantic plain, gradually deviates towards the southwest. A new chain detached on the east, and curving a little more to the south, takes now the name of Blue Ridge. It is this lofty chain, the altitude of which, in its more elevated groups, attains gradually to 5000 and 5900 feet, which divides in its turn the waters running to the Atlantic from those of the Mississippi. The line of separation, of the eastern and western waters, which, to this point, follows either the central chain of the Alleghanies, or the western border of the table-

land region, passes now suddenly to the eastern chain, upon the very border of the Atlantic plain. The reason is that the terrace which forms the base of the chains, and the slope of which usually determines the general direction of the water courses, attains here its greatest elevation, and descends gradually towards the northwest. The base of the interior chain which runs alongside the Great valley is thus depressed to a lower level, and though the chain itself has an absolute elevation greater than that of the Blue Ridge, the rivers which descend from the summits of this last, flow to the northwest towards the great central valley which they only reach, in southern Virginia and North Carolina, by first passing across the high chain of the Unaka and Smoky mountains through gaps of 3000 or 4000 feet in depth.

This southern division thus presents from southeast to northwest three regions very distinct.

The first is the high mountainous region comprised between the Blue Ridge and the great chain of the Iron, Smoky, and Unaka mountains which separate North Carolina from Tennessee. It commences at the bifurcation of the two chains in Virginia, where it forms, at first, a valley of only ten to fifteen miles in breadth, in the southern part of which flows New River; it then enlarges and extends across North Carolina and into Georgia, in length more than 180 miles, varying in breadth from twenty to fifty miles. The eastern chain, or Blue Ridge, the principal water-shed, is composed of many fragments scarcely connected into a continuous and regular chain. Its direction frequently changes and forms many large curves. Its height is equally irregular. Some, groups elevated from 5000 feet and more, are separated by long intervals of depression in which are found gaps whose height is 2200 to 3700 feet, often but little above the height of the interior valleys themselves with which they are connected. The interior, or western chain, is much more continuous, more elevated, more regular in its direction and height, and increases very uniformly from 5000 to nearly 6700 feet.

The area comprised between these two main chains, from the sources of the New River and the Watauga, in the vicinity of the Grandfather Mountain, to the southern extremity of the system, is divided by transverse chains into many basins, at the bottom of each one of which runs one of those mountain tributaries of the Tennessee, which by the abundance of their waters merit the name of the true sources of that noble river.

Between the basin of the Watauga and that of the Nolechucky rises the lofty chain of the Roan and Big Yellow mountains. The northwest branch of the Black mountain and its continuation as far as the Bald mountain separate the basin of the Nolechucky from that of the French Broad river. Between the lat-

ter and the Big Pigeon river stretches the long chain of the Pisgah and the New Found mountains. Further to the south the elevated chain of the Great Balsam mountains separates the basins of the Big Pigeon and the Tuckasegee; next comes the chain of the Cowee mountains between the latter river and the Little Tennessee. Finally the double chain of the Nantihala and Valley River mountains separates the two great basins of the Little Tennessee and the Hiwassee. The bottom of these basins preserves in the middle, an altitude of from 2000 to 2700 feet. The height of these transverse chains is greater than that of the Blue Ridge, for they are from 5000 to 6000 feet and upwards; and the gaps which cross them are as high, and often higher than those of the Blue Ridge. In these interior basins are also found groups, more or less isolated, like that of the Black mountains, which, with the Smoky mountains, present the most elevated points of the system.

Here then through an extent of more than 150 miles, the mean height of the valley from which the mountains rise is more than 2000 feet; the mountains which reach 6000 feet are counted by scores, and the loftiest peaks rise to 6700 feet; while at the north, in the group of the White mountains, the base is scarcely 1000 feet, the gaps 2000 feet, and Mount Washington, the only one which rises above 6000 feet, is still 400 feet below the height of the Black Dome of the Black Mountains. Here then in all respects is the culminating region of the vast Appalachian system.

It is worthy of notice that in the Appalachian, as in many other systems of mountains, the culminating points are situated, neither near the middle, nor in the neighborhood of what may be called its central axis, which is here the Great valley, but near the northern and southern extremities, and on the eastern side, almost outside of the system. These culminating regions seem almost exceptions to the normal structure of the system. The high mountainous region of North Carolina which has just been described is, from the bifurcation of the Blue Ridge near the great bend of the New River, an additional fold which attaches itself on the east along the principal chain which bounds the Great Valley, just as the swell, which runs along the east of the Connecticut River, upon which the group of the White mountains is situated, is an additional fold attaching itself to the east of the normal chain of the Green mountains.

The second region of this southern division is the continuation of the Great Central Valley which is divided by a general swell of the land about the sources of the Holston, into two distinct basins, the one in Virginia, narrower and more elevated, which in the basin of the New River, rises gradually towards the south from an elevation of 1600 feet to 2600 feet; the other in Tennessee, where the valley widens to nearly sixty miles between

the Smoky mountains and the Cumberland mountains, but where it has a mean elevation of not more than about 1000 feet, that is, only one-half of the height of the neighboring valleys in the mountainous region of North Carolina.

The third region is that of the plateaus which, in Tennessee, are reduced to a table land about thirty or forty miles wide, called the Cumberland mountains on account of the abrupt edges which it presents upon the east and the west, and which give to it the appearance of a mountain chain. Further north, in Virginia, the plateaus expand and fill a vast area to the west of the Clinch and the Cumberland mountains and extend over a part of Kentucky, the central portion of which, near Lexington, preserves an altitude of more than 1000 feet.

The rapid sketch here given shows that in a hypsometrical, as well as from a geological, point of view, and even to a certain extent from its physical structure, the Appalachian system seemed to be divided into two sections of nearly equal extent; a *northern section*, which is geologically more ancient, comprehending the northern division from the mouth of the Hudson to Gaspé; and a *southern section*, which is more modern, comprising the central and southern divisions, which are bound together by more than one characteristic common to both. The separation is distinguished by a remarkable general depression of all the altitudes of the eastern zone, or parallel mountain chains, a depression which attains its lowest point in New Jersey in the parallel of New York City.

Passing from this region, where the Blue Ridge and the Kittatinny mountains are but little more than 800 or 1000 feet high, and the Great valley 50 to 150 feet, the altitude in the northern section increases rapidly, but regularly, towards the northeast, where, almost in the same parallel, lat. 44° N., we find the culminating points at Mount Washington 6288 feet high in the White Mountains, Mount Mansfield 4430 feet in the Green Mountains, and Mount Tahawus or Mount Marcy 5739 feet, in the Adirondack group. Further north the Adirondack group terminates, and the Green Mountains lose somewhat of their continuity, but show here and there, as far as Gaspé, scattered groups of mountains which still preserve an elevation of 3000 or 4000 feet.

In the southern section the altitude increases from the northeast to the southwest with the same regularity but less rapidly, and it is only towards the extremity of the system in North Carolina that they attain their maximum elevation in the Black Mountains 6700 feet, and the Smoky Mountains 6660 feet. Here, as at the north, beyond the culminating points the general altitude is but little diminished until we arrive almost to the termination of the mountains.

The following figures demonstrate the law which I have announced above:

Upon the ridge which borders the Connecticut river on the east and where the elevation gradually increases from the sea coast until it reaches in Connecticut 1000 feet, in Massachusetts 1100 feet, and in New Hampshire 1600 feet at the sources of the Connecticut river, we meet with a series of mountains more or less isolated, which appear to have no other relation to each other than that they are placed on a common base.

The most remarkable of these, proceeding from the south towards the north are the following:

Mount Wachusett, in Massachusetts, - -	2018	feet	high.*
Grand Monadnock, in New Hampshire, -	3718	"	"
Moosehillock " " " - - -	4790	"	"
Lafayette Mount, } Group of - - {	5290	"	"
Mount Washington, } White Mountains, - }	6288	"	"

In the double chain of Green Mountains are the following remarkable peaks gradually increasing in height from the south to the north:

North Beacon, in the Highlands of the Hudson,	1471	feet	high.
Bald Peak, in Massachusetts, - - -	2624*	"	"
Greylock, or Saddle Mount, in Massachusetts,	3505*	"	"
Equinox Mount, in Vermont, - - - -	3872	"	"
Killington Peak, " - - - -	4221	"	"
Mansfield Mountain, " - - - - -	4430	"	"

North Beacon was probably measured by Capt. Partridge, the others were measured by myself.

In the Adirondack group I have cited only the most elevated point, Mount Tahawus or Mount Marcy, which is the only one of the great peaks which I have as yet measured. I found its height 5379 feet. This height differs from that of Redfield given in the Geology of the State of New York, (5467 feet), and from that of Prof. T. Benedict, (5341 feet). But it is to be remarked that the heights given by the first are all too great by reason of the defective nature of the instrument employed, as I have had occasion to convince myself; and also that Prof. Benedict, although provided with a Bunten barometer, was only able to make use of corresponding observations made at a considerable distance. From Tahawus the height of the peaks diminishes both towards the north and towards the south and the chains dwindle away before they reach Lake Champlain or the Mohawk River.

In the southern part the law of gradual increase is still more regular. It can also be exhibited at the exterior base of the mountains, along the Great valley, and in the principal chains

* Geodetic points in the triangulation of Massachusetts.

which border it. I have already said that the interior border of the Atlantic plain rises gradually from 50 to 1200 feet, from New Jersey to the upper region of the Catawba, near Morganton. The grade of the railroads gives us in the Great valley a series of significant points:

The Great valley			at Easton, on the Delaware in Penn.,	165 ft.
"	"	"	near the Schuylkill, Penn.,	250 "
"	"	"	at Harrisburg, on the Susquehanna,	328 "
"	"	"	at Chambersburg, Penn.,	600 "
"	"	"	near Staunton, south fork of Shenandoah, in Central Virginia,	1261 "
"	"	"	at Salem, in the upper valley of the Roanoke,	1014 "
"	"	"	Newbern in the valley of New River,	2065 "
"	"	"	Mt. Airy Ridge, highest point near the sources of the Holston,	2595 "
"	"	"	Abingdon, in Southern Virginia,	2071 "
"	"	"	Bristol, on the N. boundary of Tennessee,	1678 "
"	"	"	Greenville, Tennessee,*	1581 "
"	"	"	Knoxville, "	898 "
"	"	"	Chattanooga, "	675 "

The principal chain along the eastern border of the Great valley under the name of Blue Ridge, Iron, Smoky and Unaka Mountains, presents in the same manner an increasing altitude.

Blue Ridge in New Jersey about 1000 to - -	1500 feet.
Peaks of Otter in Virginia, the highest, - - - -	3993 "
White Top, on the boundary of Virginia, North Carolina, and Tennessee, - - - - - - -	5530 "
Bald Mountain, west of the Black Mountains, - -	5550 "
Smoky Dome, Clingman's Mountain, culminating point in the chain of the Smoky Mountains, - -	6660 "
Thunderhead, in Smoky Mountains, - - - - -	5520 "
Great Bald, highest peak, in Smoky Mountains, near the cut of Tennessee River, - - - - -	4722 "
Hangover, highest peak of the Unaka Mountains, about	5600 "
Great Frog Mountain in Tennessee, highest peak near the south end of the System. - - - - -	4226 "

The chain which from Christiansburg takes the name of Blue Ridge and forms the barrier which separates the waters along the Atlantic plain does not appear to exceed the altitude of 4500 feet in Virginia. This is only an estimate, for I have made no measurements in this portion of the Blue Ridge. In North Carolina the culminating points are much higher, but more to the south they gradually decrease as far as Georgia.

* I am indebted to Prof. Jas. M. Safford, State Geologist of Tennessee, for a statement of the altitudes on the railroads through this State.

Grandfather Mountain, at the sources of the Yadkin and Watauga rivers, measures	5897	feet.
The High Pinnacle, which touches the Black Mountain,	5699	"
Great Hogback, at the sources of the Tuckasegee,	4792	"
White-Side, near the sources of the Chatooga,	4931	"
Mud Creek Bald, near the head of Little Tennessee, Georgia,	4705	"
Tray Mountain, in Georgia, at the sources of Hiwassee River,	4426	"

Furthermore the transverse chains, which in North Carolina unite the two principal chains, and the interior isolated groups in which the highest summits are found, present altitudes increasing as they proceed, culminating, however, more towards the north.

Roan Mountain, High Knob, which joins the Iron mountain chain on the east,	6306	feet.
Black Dome, or Mitchell's High Peak, the culminating point of the Appalachian System,	6707	"
Richland Balsam, in Big Pigeon Valley,	6425	"
Amos Plott's Balsam, in Tuckasegee valley,	6278	"
Yellow Mountain, Cowee Chain, between the Tuckasegee and Little Tennessee valleys,	5108	"
Standing Indian, highest point in the Nantihala chain,	5518	"
Fodders' Bald, in Hiwassee valley, Georgia,	4821	"

The law of general increase of altitude towards the southwest in all parts of the Appalachian system, is thus fully established; but it is to be remarked that the different elements of which it is composed do not arrive to their maximum of altitude in the same locality nor in the same latitude. The bottom of the Great valley reaches its greatest elevation near the sources of the Holston, at about 37° N. lat. The mass elevation, or terre-plein, culminates in the vicinity of Grandfather and Big Yellow mountains. The isolated groups and intermediate chains, culminate in the Black mountains, a little south of 36° N. lat., although, in this region, the principal chains on the two sides do nowhere rise to 6000 feet; while these last, the Blue Ridge and the Smoky Mountains, reach their greatest mean and absolute height at the north of 35° N. lat., between the valleys of the French Broad and Little Tennessee, in the northern part of Haywood and Jackson counties. Although the high peaks of the Smoky mountains are some fifty feet lower than the isolated and almost exceptional group of the Black mountains, by their number, their magnitude, the continuity and general elevation of the chains, and of the base upon which they repose, they are like a massive and high citadel which is really the culminating region of all the Appalachian system.

To complete this brief review I ought to add that this increasing altitude towards the south which is so well marked in the mountain zone of the Alleghanies, is scarcely observed in the

zone of the plateaus. A transverse section from New York to Lake Erie shows that the depression of the system does not extend to the western zone which preserves in appearance a height very nearly uniform, from the plateau of Adirondack in the State of New York as far as to the Cumberland mountains in Tennessee. There is here no well marked region of subsidence as in the eastern zone, but only a tendency to it which is slightly manifested upon a line between the maximum of eastern depression and Pittsburg. It is towards that central line of depression that the Alleghany and Monongahela rivers flow from opposite directions, thus proving the existence of inclined planes which meet about Pittsburg, forming a sort of shallow trough. North of this line the plateaus rise to the sources of the Alleghany and Susquehanna rivers, where, as was said above, they reach an altitude of over two thousand feet; still keeping, further north, on the table-land of Adirondack a mean elevation of 1500 and 1600 feet. Towards the south also the plateaus rise to the sources of the Monongahela. In Virginia and Tennessee they appear to reach 2000 or 2500 feet, at least near the mountains, but the measurements which I possess are too few in number and too uncertain to allow me to speak with certainty on this subject.

This remarkable depression of the Appalachian system in the region noticed, of which the bay of New York is the center, causes a great part of the continental plains, which form the natural base of the mountain folds, to disappear under the waters of the ocean. The waters of the tide thus come to bathe the very base of the mountains, and the region of plains fades away on the frontiers of New Jersey and New York, while towards the south the emerged portion enlarges gradually as it rises according to the law of gradual increase indicated above, so that it reaches a breadth of more than 200 miles in the Carolinas. This depression seems to be due to a local subsidence of the earth crust at an epoch, undetermined, it is true, but which must have been posterior to the principal upheaval of the Appalachian mountains. A fact, the discovery of which is due to the sagacity of Prof. J. D. Dana, seems to give weight to this opinion. He demonstrated by means of numerous soundings marked upon the excellent marine charts published by the U. S. Coast Survey, the existence of an ancient channel, a continuation of that of the Hudson river, which goes out from the bay of New York through the Narrows and advances far out under the waters of the ocean. It is not possible to suppose that such a channel which is constantly liable to be obliterated by sand banks formed by the motion of the sea, could have ever been formed in its present position. In order that the current of the river should excavate this channel it is necessary to suppose that the bottom of the sea has once occupied a higher level,

above, or very near the surface of the ocean. The shallowness of the ocean for a considerable distance from the coast of New Jersey also indicates a prolongation of the continental plains under the sea, and the limit of the deep waters is there found at a distance nearly double that which is observed off the coast of the Carolinas. Moreover the parallelism which exists between the line of coasts and all the great general inflections of the Appalachian system, a parallelism which is well marked from Nova Scotia to Florida, here undergoes a modification which is well explained only by a local depression of this part of the system. The fact that all New Jersey is now undergoing gradual submergence from Cape May to the Bay of New York, which is proved by the numerous facts gathered by Prof. G. H. Cook in the Geological Survey of the State of New Jersey, is here not without signification.

The disposition of the relief indicated above would be readily accounted for by supposing that it is the result of a tilting motion from the north to the south, which, while depressing the northern portion below the mean altitude, elevated the southern region in the same proportion, the centre or axis of the tilt being in the vicinity of Christiansburg, near the Great Bend of the New River. As the movement affected more particularly the eastern, or mountainous belt, and not that of the plateaus of the west, the result of it was a twisting, the effect of which was to raise, in the southern part, the mass of the land on the extreme eastern border and thus to produce an inclined plane towards the northwest; while in the northern part, the general depression of the land along the Atlantic, a depression not participated in by the plateaus of the northwest, left to these latter all their altitude and produced an inclined plane from the extreme western border towards the southeast. It is then this particular disposition of these two general slopes which gives us the key of the hydrographic system of the central and southern divisions of the Appalachian mountains, which at the first glance appears so abnormal. In the central section, as has been remarked above, north of New River, the water-shed is situated along the edge of the plateaus in the Alleghany mountain proper in Virginia and Pennsylvania, from which descend the James River and the Potomac; and still further to the west in the plateaus of New York from which flow the Susquehanna and the Delaware, traversing all the chains of the mountainous region to the Atlantic. In the southern division, south of New River, the water-shed between the Atlantic and the Mississippi basin is situated upon the summit of the Blue River at the extreme eastern edge, and the numerous tributaries of the Tennessee which descend from it also traverse the whole mountainous region, but in an inverse direction, from the southeast to the northwest, and, united in the

Great Valley at the very foot of the plateaus of the northwest, flow down by the sole channel of the Tennessee to the basin of the Mississippi.

As many of the names of mountains given below in the list of the heights measured are new, I may be allowed a few words on the subject of mountain nomenclature.

It is a mistake to suppose that names have been given to even the most prominent points in the mountains of the Appalachian system. Just in the wildest and most elevated regions, such as western North Carolina, for instance, the great majority of them have yet to be named. In a country without a regular chart, and in the midst of forests rarely visited, far from any human habitation, and in places where the primitive inhabitants have disappeared, leaving scarcely a trace of their traditions, it is not surprising that this should be the case.

The uniformity of physical configuration in a great portion of the system does not favor distinguishing different parts by specific names. Frequently people are satisfied with giving a name to a mountain range, or to a district of great extent. The observer who measures the height of definite points must do more. In order to make his labors useful, he ought to designate them individually, and determine their position so that they can always be identified, or afterwards traced upon a chart. It is, therefore, almost a matter of necessity for him to sketch such a map while proceeding, and to name, either ill or well, the points determined by his observations. A good geographic nomenclature, however, is not an easy thing; the chart of the United States proves this.

The names of objects in physical geography now in use in this country are essentially of three kinds. The Indian names which have been bequeathed to us by the aborigines, and are applied more commonly to the water courses and lakes, and especially to their towns or districts; descriptive names, as White Mountains, Black Mountains, Green Mountains, which designate entire chains or groups of mountains; and the names of men, which are applied to all. These last are the more numerous.

Wherever an Indian name is in use it ought to be preserved except where, as sometimes happens, its pronunciation is impossible for us. These names, especially in the languages of the south, are often harmonious and they are all significant, but unhappily without meaning for us. In the south they are rarely applied to mountains, although the Indian name of a river which flows near frequently extends to a neighboring chain of mountains. Indian names, designating special mountain peaks, are not common, perhaps because not preserved by the white settlers, who did not live with, but succeeded the Indian population. The more modern descriptive names have the defect of

great similarity, for in an extent of thirteen hundred miles the topographical characters are singularly analogous. The multiplication of the same name in all parts of the system becomes here, as in political geography, a serious evil. Green, Blue, and Black mountains are found alike at the south and at the north; White mountain, White face, White side, &c., are also numerous. Chestnut, Oak, Pine mountain and Laurel mountains are found everywhere. In the South, Balsam mountains occur at every step from southern Virginia to Georgia. This name designates a mountain whose summit is covered with *Pinus Balsamifera*, or with its analogous species, *Pinus Frazeri*, which only grow on heights which exceed 5000 or 6000 feet. The Bald Mountains whose summits are destitute of forests, a thing comparatively rare at the south, are yet very numerous. It only remains for the geographer, in order to avoid intolerable confusion, to add to such names another name, or epithet, as Richland Balsam, Smoky Bald, and other similar designations.

These difficulties explain, and excuse perhaps in part, the frequent use in America of names of men to designate places, rivers, and mountains. This course requires the least effort of the imagination. A river without a name commonly takes that of the first planter who erects there his cabin or farm-house, and if there is a remarkable mountain near, it is soon designated by the same name. This is the origin of a great number of the names, more convenient than elegant, of the mountains and valleys of the Alleghanies. It is but recently, since scientific measurements have been made, that the names of men, distinguished either in the political or scientific world, have been given to prominent mountains in New England, in the state of New York and at the South.

The principles which have seemed to me proper and which have guided me in the adoption of names of mountains are to give preference to the name employed in the immediate neighborhood of the point designated. When more than one name has been given to the same point, as happens when it is seen from valleys on two different sides of the mountain, it seems proper for the observer to adopt that name which appears most natural or more euphonic. When the choice lies between the name of a man and that of a name which is descriptive and characteristic, I should choose the latter. In regard to points without established names, but recently named by scientific observers, and not by residents of the country, the right of priority ought to be respected, provided the identity of the points can be sufficiently established, a matter by no means easy, unless the positions have been determined by instruments, or otherwise, with considerable care. But it is evident that popular usage will decide in the last resort and that the name universally adopted

will, in time, become that which geography ought to accept. When I have myself given names to mountains, I have almost always preferred a descriptive name to any other; but I acknowledge that the invention of names is a thankless and difficult task. I have, therefore, frequently had recourse to the names of neighboring rivers, or to a fortuitous circumstance, or to some little adventure, connected in my memory with this or that point to designate it, without any other object than that of distinguishing it from every other, since here as elsewhere it is better to accept almost any name rather than to leave it all in confusion.

The map which accompanies this paper was first published in Petermann's *Mittheilungen*, No. vii, 1860: it was drawn, in Gotha, with all the data at his command, by my friend and assistant Mr. E. Sandoz under the kind and skillful direction of Dr. A. Petermann, who by his admirable cartographic labors and manifold services rendered to the science of the physical globe, has long since placed himself among the most useful and scientific geographers of the day. The special map of the Black Mountain has been constructed from my own observations; the points measured having been located by means of a portable theodolite and sextant. In the map of the White Mountains the position of the points measured has been taken from the anonymous map which we owe to Prof. Bond, of Cambridge Observatory, and which was constructed from similar observations by himself. In this new edition of the general map an important correction has been made. The mountain region of North Carolina was engraved anew from a sketch founded upon my observations of 1859 and 1860. A map of that interesting region, on a larger scale, and one of the Black Mountains, showing the position of all the points measured, are in preparation and will be published, together with the discussion and results of the barometric observations, in the Smithsonian Contributions, to which I must refer for further details.

The accompanying list of heights which I have measured is classified according to physical regions. The measurements are of two kinds: those which are marked B are the heights regularly measured by the barometer; those marked P L are heights measured at a distance with a pocket level in the following manner. Wishing to measure a mountain in sight, at a moderate distance, and not exceeding in elevation the one on which I stand, I seek, with the instrument in hand, a point on a level with the summit of the mountain to be measured. Taking then at that point a barometric observation, I consider the result, corrected for the curvature of the earth and for refraction, as the height of the mountain. With an accurate level, a signal upon the mountain, and the knowledge of the exact distance a meas-

urement thus taken would stand the same chance of accuracy as the former; with a pocket level, without a telescope, the results must be considered as approximations which may be very nearly correct, but which also may, according to the distance from which the observation was taken, vary by the height of a tree, that is to say from thirty to fifty feet. They are therefore only preliminary measurements which, while the country remains comparatively unknown, have their proper value in physical geography. I have added for reference a few points marked R R, which are elevations obtained from recent surveys for railroads, and L, which are also determined, for other purposes, by spirit-level. The chart was in part engraved before the revision of the heights given below. New measurements of points previously determined having since taken place, their results ought to have their due influence on the final values. It may happen therefore that there may be found a difference of several feet between the figures given in the table and those inscribed in the map; in those cases the figures given in the table are those which I regard as nearest to the true height. Some ancient measurements of heights in New England have been inadvertently inserted in the chart such as Wachussett 3000 instead of 2018, and some others of this sort which have been recently corrected.

The heights are given in English feet, and above mean tide-water. They are all reduced to the ground, or, for the rivers, to the level of the water.

Culminating Region of the Northern Section.

White Mountains and Vicinity.

Western Slope.—Valley of the Amonoosuc.

		Height.
R.R.	Connecticut River, junction with Wells River,	407
R.R.	Bath village,	531
R.R.	Lisbon village,	577
R.R. and B.	Littleton, R. R. station,	817
R.R.	Whitefield, summit between Littleton and Lancaster,	1057
	Whitefield village,	957
R.R.	Lancaster village,	860
R.R.	Israel River, Lancaster bridge, St. Lawrence and Atlantic R. R.	849
B.	Bethlehem village,	1450
B.	Carrol house,	1428
B.	Bethlehem bridge on the Amonoosuc,	1221
P.L.	Brabrook's hotel,	1551
B.	Fabyan's Hotel (old house, now burnt),	1583
B.	Crawford Hotel (Crawford house), White Mt. Notch,	1920
B.	Franconia village, iron foundry,	921
B.	Gilmanton Hill, summit between Franconia and Littleton,	1329
B.	Franconia Valley, crossing of road to Bethlehem,	979
B.	Franconia Notch, Profile house,	1974
B.	Franconia Notch, height of land towards Franconia,	2014
B.	Echo Lake,	1926
B.	Cherry Mt., Summit road,	2192
B.	Cabin, foot of Lafayette Mt.,	1780
B.	Flume house, road front of the Hotel,	1431
B.	Thornton, road opposite the Post Office,	1223
R.R.	Plymouth R. R. station,	473

Eastern Slope.—Valley of the Saco.

		Height.
B.	Notch of White Mts., Crawford house,	1920
B.	The Notch,	1904
B.	Willey house, road opposite the hotel,	1335
B.	Old Crawford's or Davis's hotel,	986
B.	Hart's location, Farm junction, Sawyer's River,	880
B.	Upper Bartlett's Post Office,	644
B.	Crossing of the road's junction of the Saco and Ellis River valleys,	576
B.	South Conway Post Office,	450
Δ	Pleasant Mt., east of Freyeburg, Me. (Coast Survey),	2021

Valleys of Ellis and Sawyer's Rivers.

B.	Jackson Village, hotel foot of the Falls,	771
B.	Pinkham Notch, summit near Glen Ellis Falls,	2018
B.	Junction of Carrigain Brook and Sawyers River,	1494

Northern Slope.

R.R.	Gorham, N. Hampshire, R. R. station, St. Lawrence and Atlantic R. R.,	802
L.	Glenhouse hotel,	1632
B.	Bowman's place, Summit road, between Moose and Israel Rivers,	1446
R.R.	Lowest Summit, R. R. Summit " " " " " "	1473
B.	Peabody River, crossing of path near Glenhouse,	1543
R.R.	Great Androscoggin River at Bethel station,	632
R.R.	Paris station, St. Lawrence and Atlantic R. R.,	396
R.R.	Little Androscoggin River at Danville junction,	276

Mt. Washington, the main chain or the chain of the Presidents, ascending from White Mountain Notch.

B.	Mt. Clinton,	4320
B.	Mt. Pleasant,	4764
B.	Mt. Franklin,	4904
B.	Mt. Monroe,	5384
B.	Mt. Washington, culminating point of northern section,	6288
B.	Mt. Clay,	5553
B.	Mt. Jefferson,	5714
B.	Mt. Adams,	5794
B.	Mt. Madison,	5365
B.	Lake of the Clouds, head waters of Amonoosuc River, foot of Monroe,	5009
B.	Gap between Madison and Jefferson,	4912
B.	" " Jefferson and Adams,	4989
B.	" " Adams and Clay,	4979
B.	" " Clay and Washington,	5417
B.	" " Washington and Monroe,	5100
B.	Little Monroe, W.S.W. of Monroe,	5204
B.	Gap between Franklin and Pleasant,	4400
B.	" " Pleasant and Clinton,	4050
B.	Limit of trees on Washington, N. side, and Madison,	4150
B.	Halfway house on new road, below the Steep slope,	3840
B.	Limit of trees on Clinton,	4250

Secondary chains around the main.—West of Amonoosuc River.

B.	Mt. Deception, near Fabyan's,	2449
P.L.	Cherry Mt., approximately,	3670

Chain, East of Peabody R. and Glenhouse.

P.L.	Wildcat Mt.,	4330
P.L.	Mt. Carter, South Peak,	4880
P.L.	Mt. Carter, North Peak,	4703
P.L.	Mt. Morijah,	4653
P.L.	Crawford Mt.,	3134

Chains South of the Amonoosuc River.

P.L.	Echo Mt., highest point,	3170
P.L.	The Villey, or Notch chain, the lowest or 3d N.W. peak,	4070
P.L.	Middle or highest peak, very much as Clinton by level about,	4330
P.L.	Willey Mt. proper, 1st or East peak,	4300
P.L.	Twin Mt., the highest peak,	4920

South side, between Saco Valley and Merrimac River.

		Height.
B.	Carrigain Mt.,	4678
B.	Summit of Eastern Spur,	4419
P.L.	Brick house Mt., in the line N.E. 2 miles from Carrigain,	3850
P.L.	Pemigewassett Peak,	4420
P.L.	Tremont Mt.,	3393
P.L.	Green's Cliff,	2958
P.L.	Table Mt., 3 miles S.S.E. of Hart's ledge,	3305
P.L.	Sandwich Dome, above Campton,	3969
P.L.	Mad River peak, head of Mad River,	4397
P.L.	Whiteface, N.E. peak, the highest,	4030
P.L.	Tripyramid, N.W. of Whiteface, S. of Carrigain,	4086
P.L.	Chicorua, highest peak south,	3540

Group of Franconia Mts.

P.L.	Eagle Cliff, facing the Profile house,	3446
B.	Eagle head, near the pond,	4216
B.	Eagle pond, foot of last peak,	4170
B.	Lafayette or Great Haystack,	5290
B.	" " " South peak,	5101
P.L.	Summit of Blue or Bog-Eddy Mt., the highest part of the chain of Cannon, Kinsman and Blue Mt.,	4370
P.L.	Kinsman Mt. about	4200
B.	Cannon Mt., the prospect, appr.,	3850

West and South of the White Mts.

B.	Moose hillock, highest peak north,	4790
P.L.	Carr's Mt., highest summit,	3480
P.L.	Owl's head,	2950
P.L.	Webster side, south side of the R. R. opposite,	2210
B.	Highest farm foot of Moose hillock S.,	1681
R.R.	Warren Village,	736
R.R.	Summit of Road,	1063
R.R.	East Haverhill,	773
R.R.	Woodville R. R. station opposite Wells' River,	448
R.R.	Connecticut low water, " " "	407
R.R.	Rumney R. R. station,	520
R.R.	Plymouth village, R. R. station,	473
R.R.	Meredith Village,	543
R.R.	Concord, N. Hampshire, R. R. station,	237

Redhill and Winnipeseogee Lake.

R.R. and Canal.	Lake Winnipeseogee, mean level,	501
B.	Senter house at Centre Harbor, Lake Winnipeseogee,	553
B.	Eastern summit of Redhill,	1769
B.	Western summit " "	2025

GREEN MOUNTAINS.

B.	Manchester R. R. station,	713
B.	" Village courthouse,	864
B.	Equinox Mt., highest peak,	3872
R.R.	Rutland R.R. station,	530
B.	Herrick Mt., near Rutland,	2892
B.	Shrewsbury Peak,	3845
B.	Pico Mt., north of Killington,	3954
B.	Killington Peak,	4221
R.R.	Waterbury R. R. station,	425
P.L.	Hogback Mt.,	3648
B.	Stowe Village, foot of Mansfield Mt.,	700
B.	Mansfield Mt., the Nose,	4094
B.	Mansfield Mt., the Chin, highest,	4430
P.L.	Sterling Chain,	3700
B.	Camel Hump,	4088
P.L.	Lincoln Mt.,	4078

PLATEAU AND MOUNTAINS OF ADIRONDACK.

Profile from Lake Champlain to Mt. Tahawus from E. to W. by N.

		Height.
L.	Lake Champlain, mean level,	98
B.	Crown Point tavern,	206
B.	Bradford farm, road summit,	695
B.	Amyhill summit road,	844
B.	Buckhollow, hamlet water of Putnam Creek,	719
B.	Penfield, water of Putnam Creek,	910
B.	Height of land dividing the Hudson and St. Lawrence waters,	1199
B.	Hammond's furnace,	1132
B.	Paradox Creek at Hammond's saw-mill,	911
B.	" " " crossing of road from Paradox Lake to Root's,	873
B.	Summit of road between Paradox crossing and Johnson's pond,	1256
B.	Johnson's pond,	964
B.	Summit of road between Johnson's pond and Root's in Schroon valley,	1263
B.	Root's farm, ground, in Schroon Valley,	842
B.	Sturtevant's mill on Mud creek,	1113
B.	Mudpond creek,	1206
B.	Summit of road between Mud creek, crossing of French's,	2013
B.	French's farm, road before,	1062
B.	Grand Boreas river, bridge,	1736
B.	Summit road, west of Boreas river,	1935
B.	Lake Sanford at Millpond,	1731
B.	Adirondack Village, or McIntyre's iron-works, hotel,	1785
B.	Summit above Beaver Marsh,	2782
B.	Lake Colden,	2786
B.	Hudson River, Great Bend,	3264
B.	Limit of trees on Mt. Marcy and Whiteface,	4851
B.	Mt. Tahawus or Mt. Marcy,	5379
L.	Lake Henderson,	1829
L.	Head of Falls,	2550
L.	Surface of Beaver marsh,	2677
L.	Summit above Beaver marsh,	2762
L.	Surface of opalescent River (Hudson),	2744

These last five altitudes are derived from levels above Lake Sandford taken by Prof. E. N. Horsford.

Culminating Region of the Southern Section.

THE BLACK MOUNTAINS AND VICINITY.

Valley of the Swananoa.

R.R.	Junction of Flat Creek with Swananoa River,	2250
B.	Joseph Stepp's house,	2360
B.	Burnett's house,	2423
B.	Lower Mountain house, Jesse Stepp's house, floor of Piazza,	2770
B.	W. Patton's cabin, end of carriage road,	3244
B.	Resting place, brook behind last,	3955
B.	Upper Mountain house,	5246
B.	Passage, main branch of Swannanoa above Stepp's ascending to	
B.	Toe River Gap,	3902

In the Blue Ridge.

B.	Toe River Gap, between Potatoe Top and High Pinnacle,	5188
B.	High Pinnacle of Blue Ridge,	5701
B.	Rocky Knobs, south peak,	5306
B.	Big Spring on Rocky Knobs,	5080
B.	Greybeard,	5448

Craggy Chain.

B.	Big Craggy,	6090
B.	Bull's Head,	5935
B.	Craggy Pinnacle,	5945

The Black Mountain, main chain.

B.	Potatoe Top,	6393
B.	Mt. Mitchell,	6582
B.	Mt. Gibbs,	6591
B.	Stepp's Gap, the cabin,	6103

		Height.
B.	Mt. Hallback (or Sugarloaf),	6403
B.	Black Dome (or Mitchell's high peak, or Clingmann of State map),	6707
B.	Dome Gap,	6353
B.	Balsam Cone (Guyot of State map),	6671
B.	Hairy Bear,	6610
B.	Bear Gap,	6234
B.	Black Brother (Sandoz of State map),	6619
B.	Cattail Peak,	6611
B.	Rocky Trail Gap,	6382
B.	Rocky Trail Peak,	6488
B.	Cattail Gap,	5720
B.	Deer Mt., North Point,	6233
B.	Long Ridge, South Point,	6208
B.	" " Middle Point,	6259
B.	" " North Point,	6248
B.	Bowlen's Pyramid North End,	6348
	The Black Mountain, Northwestern Chain.	
B.	Blackstock Knob,	6380
B.	Yeates's Knob,	5975
B.	Cock's Comb,	5426
	Caney River Valley.	
B.	Green ponds at Th. Wilson's, highest house,	3222
B.	Th. Wilson's new house,	3110
B.	Wheelers' opposite Big Ivy Gap,	2942
B.	Cattail fork Junction with Caney River,	2873
B.	Sandofer Gap or low Gap, Summit of Road,	3176
B.	Burnsville, courtsquare,	2840
B.	Green Mountain near Burnsville, highest point,	4340
	Group of the Roan Mountain.	
B.	Summit of Road from Burnsville to Toe River,	3139
B.	Toe River ford on the Road from Burnsville to the Roan Mountain,	2131
B.	Baily's farm,	2379
B.	Brigg's house foot of Roan Mt., Valley of Little Rock creek,	2757
P.L.	Yellow Spot above Brigg's,	5158
P.L.	Little yellow Mount, highest,	5195
B.	The cold spring summit of Roan,	6132
P.L.	Grassy Ridge Ball N.E. continuation of Roan Mt.,	6230
B.	Roan high Bluff,	6296
B.	Roan high Knob,	6306
	From Burnsville to Grandfather Mountain.	
B.	South Toe River Ford,	2532
B.	Toe River; ford near Autrey's,	2547
B.	North-Toe River ford, below Childsville,	2652
B.	Blue Ridge, head of Brushy creek,	3425
B.	Linville river ford below head of Brushy creek,	3297
B.	Linville River at Piercy's,	3607
B.	Headwaters of Linville and Watauga River, foot of Grandfather Mt.	4100
B.	Grandfather Mt. summit,	5897
B.	Watauga River at Schull's millpond,	2917
B.	Taylorsville, Tennessee,	2395
B.	White Top, Virginia, corner of Tenn. and N. Car.	5530
	From Burnsville to the Bald Mt.	
B.	Sampson's Gap,	4130
B.	Egypt cove at Proffitts,	3320
B.	Wolfs' camp Gap,	4359
B.	Bald Mt. summit of highest peak,	5550

These four points computed by me from observations made by Prof. W. C. Kerr of Davidson College.

	Valley of the Big Ivy Creek.	
B.	Dillingham's house, below Yeates' Knob, or Big Butte,	2568
B.	Junction of the three forks of Big Ivy,	2276
B.	Salomon Carter's house,	2215
B.	Stockville, at Squire Black Stocks',	2216
R.R.	Mouth of Ivy River, by Railroad survey,	1684

REGION OF THE GREAT BALSAM MOUNTAINS.

From Asheville to Mt. Pisgah.

		Height.
B.	Asheville courthouse,	2250
B.	Sulphur springs, the spring,	2002
B.	Hominy cove at Salomon Davis's,	2542
B.	Little Pisgah west,	4724
B.	Great Pisgah,	5757

Big Pigeon Valley.

B.	Forks of Pigeon at Col. Cathey's,	2701
B.	East fork of Pigeon, at Cap. Th. Lenoir's,	2855
B.	Waynesville, courthouse,	2756
B.	Sulphur spring, Richland Valley, at James Love's, Esq.,	2716
B.	Mr. Hill's farm, on Crabtree creek,	2714
B.	Crab Tree creek, below Hill's farm,	2524
B.	Cold Mountain,	6063

Chain of the Richland Balsam, between Richland Creek and Big Pigeon River.

B.	Richland creek, at E. Medford's,	2938
B.	E. Medford's farm, foot of Lickstone Mt.,	3000
B.	Lickstone Mountain,	5707
B.	Deep Pigeon Gap,	4907
B.	Cold Spring Mountain,	5915
B.	Double Spring Mt.,	6380
B.	Richland Balsam, or Caney fork Balsam divide,	6425
B.	Chimney Peak,	6234
B.	Spruce Ridge Top,	6076
B.	Lone Balsam,	5898
B.	Old Bald, head of Richland Creek,	5756

Chain of Westener Bald.

B.	Westener Bald North Peak,	5414
B.	" " " Pinnacle,	5692

Great Middle Chain of Balsam Mountains between Scott's Creek and Soco Creek.

B.	Enos Plott's farm North foot of chain,	3002
B.	Old Field Mountain,	5100
B.	Huckelberry Knob,	5484
B.	Enos Plott's Balsam first Balsam North End,	6097
B.	Junaleska, or Jones' Balsam N. Point,	6223
B.	" " S. End,	6055
B.	Rockstand Knob,	6002
B.	Brother Plott,	6246
B.	Amos Plott's Balsam, or Great divide,	6278
B.	Rocky-face,	6031
B.	White-Rock Ridge,	5528
B.	Black-Rock,	5815
B.	Panther-Knob,	5359
B.	Perry Knob,	5026

Valley of Scott's Creek.

B.	Love's Sawmill, on Richland Creek,	2911
B.	Maclure's farm " "	3285
B.	Road Gap head of Scott's Creek,	3357
B.	John Brown's farm, Scott's Creek Valley,	3049
B.	Bryson's farm,	2173
B.	John Love's Esq., farm,	2226
B.	Webster Courthouse,	2203

Valley of Tuckasegee and tributaries.

B.	Tuckasegee River and mill below Webster, near road to Qualla,	2004
B.	Junction of Savannah creek,	2001
B.	" " Scott's creek,	1977
B.	Quallatown, main store,	1979
B.	Soco River, ford to Oconaluftee,	1990
B.	Soco Gap, road summit,	4341
B.	Amos Plott's farm, in Jonathan's Creek Valley,	3084

		Height.
B.	Oconaluftee River, junction Bradley fork,	2203
B.	Robert Collins, Esq., highest house,	2500
B.	Junction of Ravens, and Straight forks,	2476
B.	Junction of Bunch's creek,	2379

CHAIN OF THE GREAT SMOKY MOUNTAINS.

North of Road Gap.

B.	Luftee Knob, head of straight fork of Oconaluftee River,	6232
B.	Thermometer Knob,	6157
B.	Ravens Knob,	6230
B.	Tricorner Knob,	6188
B.	Mt. Guyot, (so-named by Mr. Buckley), in Tennessee,	6636
B.	Mt. Henry,	6373
B.	Mt. Alexander,	6447
B.	Mt. Alexander, South peak,	6299
B.	The Three Brothers, highest or central peak.	5907
B.	The Thunderknob,	5682
B.	Laurel peak,	5922
B.	Reinhardt Gap,	5220
B.	Top of Richland Ridge,	5492
B.	Indian Gap,	5317
B.	Peck's peak,	6232
B.	Mt. Oconn,	6135
B.	Right hand, or new Gap,	5096
B.	Mt. Mingus,	5694

Group of Bullhead, Tennessee.

B.	Central peak or Mt. Leconte,	6612
B.	West peak, or Mt. Curtis,	6568
B.	North peak, or Mt. Safford,	6335
B.	Cross Knob,	5931
B.	Neighbor,	5771
B.	Master Knob,	6013
B.	Tomahawk Gap,	5450
B.	Alum Cave,	4971
B.	Alum Cave creek junction with little Pigeon River,	3848

Great Smoky Mountains, South of Road Gap.

B.	Road Gap,	5271
B.	Mt. Collins,	6188
B.	Collins Gap,	5720
B.	Mt. Love,	6443
B.	Clingmann's Dome,	6660
B.	Mt. Buckley,	6599
B.	Chimzy Knob,	5588
B.	Big Stone Mt. head of Forney Ridge,	5614
B.	Big Cherry Gap,	4898
B.	Corner Knob,	5246
B.	Forney Ridge peak,	5087
B.	Snaky Mountain,	5195
B.	Thunderhead Mountain,	5520
B.	Eagle Top,	5433
B.	Spence Cabin,	4910
B.	Turkey Knob,	4740
B.	Opossum Gap,	3840
B.	North Bald,	4711
B.	The Great Bald's Central Peak, near the Gap of Little Tennessee,	4922
B.	" " " South Peak,	4708
B.	Tennessee River, Hardin's,	899
B.	Chilhowee Mt. Summit road to Montvale Springs,	2452
B.	Montvale Springs Tennessee, Main Building,	1293

The numerous altitudes measured in the summer of 1860 during an exploration of two months not being ready for publication, will be given in another communication.

Princeton, New Jersey, January, 1861.

Art. XIV.—*On the Formation of Picramic Acid;* by M. Carey Lea.

It is to Mr. Aimé Girard that we owe the first isolation of picramic acid, and correct determination of its constitution. His views however of the circumstances under which it is formed do not altogether agree with the results of my observations, and I advert to them now, because his second paper contains a criticism on the results obtained by another chemist, which criticism I think depends upon an inexact view of the reactions.

In a paper published by Dr. Evan Pugh in Liebig's Annalen, he endeavored to establish the identity of picramic acid with Wöhler's nitrohæmatic acid. Mr. Girard, while he agrees with Mr. Pugh in his conclusions, rejects his experiments and reasonings as insufficient.

"This chemist, in fact" he says "proceeded exactly as Mr. Wöhler had done before I demonstrated the formation of picramic acid by means of sulphydric acid. His process consists in mixing picric acid with protosulphate of iron, boiling with excess of baryta, precipitating the soluble baryta salt with ammoniacal acetate of lead and *finally in decomposing the lead salt by sulphydric acid.* Now it is evident that under these circumstances, even supposing that the protoxyd of iron had not converted the picric acid to picramic, the sulphydric acid alone would have produced this reduction." *

At first sight this conclusion seems perfectly legitimate, so much so, that it is probable that no test by experiment was thought necessary. Had such been made it would have been ascertained that sulphydric acid *is wholly without power to reduce* picric acid whether free or in combination with lead, to picramic acid.

The fact appears to have been overlooked that sulphydric acid is quite incapable of producing this reaction either upon picric acid, or as far as my experiments go, upon any picrate. It is the alkaline sulphids that possess this power, and not free sulphydric acid, a circumstance which has not been noticed, in consequence of chemists operating on solutions of picric acid in alcohol to which excess of ammonia had been added. When sulphydric acid is passed through such a solution, sulphydrate of ammonia is formed and acts on the picric acid.

Sulphydric acid may be passed through solutions of picric acid, picrate of potash or picrate of ammonia, either at ordinary temperatures, or at a boiling heat, for any length of time, without producing the slightest effect. On the addition of excess of alkali the reducing effect of the sulphid formed is immediate.

Philadelphia, Nov. 30, 1860.

* Comptes Rendus, xlii, 59.

ART. XV.—*Remarks on a proposed Process for the Estimation of Nitrogen, and on an Acidimetric Process;* by M. CAREY LEA.

IN a late number of the London Chemical News* a modification of Will and Varrentrapp's process for the estimation of nitrogen is proposed by Mr. J. Walker. He decomposes the substance in a combustion tube in the ordinary way, but instead of conducting the products of the combustion into chlorhydric acid, conducts them into solution of chlorid of zinc, and in place of determining the ammonia in the usual manner, determines the amount of oxyd of zinc precipitated by it. "This process," the author observes, "has been practised by me for the last two years, and gives most accurate results, and I can with perfect confidence recommend it."

Few chemists would be apt to adopt a process so obviously worthless, but as its author recommends it especially for the analysis of manures, and as in that way it might be employed for technical purposes, it seems desirable that its gross inaccuracy should be pointed out. Oxyd of zinc is well known to be easily soluble in ammonia salts: if a drop of caustic ammonia is let to fall into a solution of pure neutral chlorid of zinc, it occasions a precipitate of oxyd, if now solution of sal-ammoniac be added, the precipitate redissolves. Obviously if more ammonia, instead of sal-ammoniac, is added, sal-ammoniac is formed by the decomposition of the zinc salt, and a portion of the precipitate is redissolved by it, or to speak more correctly, a portion of the oxyd of zinc which is liberated by the ammonia, is held in solution by the sal-ammoniac. The necessary result must be an under-estimation of the ammonia, leading to errors of such magnitude as would render the process wholly unfit even for the roughest technical process.

In consequence of overlooking the frequent solubility in alkaline solutions of certain metallic oxyds and basic salts insoluble in water, even chemists of experience have been led into singular errors. Dr. Friedrich Mohr in his interesting book on Volumetric Analysis, highly recommends a process proposed by Kieffer for acidimetric estimation, and which is briefly as follows. Sulphate of copper in solution is treated with liquid ammonia until the precipitate formed is nearly redissolved; it is then filtered, diluted to a certain strength and constitutes the test liquid. If this be dropped into an acid, or an acid solution, after the addition of a certain quantity a precipitate falls, the appearance of which Kieffer and Dr. Mohr consider to mark the moment

* Nov. 24, 1860, p. 280.

of the exact saturation of the acid liquid by the joint action of the ammonia and copper. Dr. Mohr observes:*

"Donc le moindre excès de la liqueur de dosage formera un précipité bien net, tout à fait insoluble dans la dissolution des deux sels complétement neutres."†

Here is an important error, this precipitate is by no means insoluble in such solutions, it is soluble with considerable facility in solution of sulphate of ammonia (in the above passage Dr. Mohr refers more particularly to the dosing of sulphuric acid) and also, though to perhaps not to so great an extent, in solutions of sal-ammoniac and of nitrate of ammonia. Consequently when the precipitate appears, it is because the solution is saturated with it. If it were not that the effect of the cupro-ammoniacal solution is directed to be determined empirically and not by calculation, this solubility would have led to discrepancies no doubt sufficiently great to have awakened suspicion. But the error is just sufficiently great to make the process dangerous. More or less of the precipitate is held in solution according as the saline solution is more or less dilute. Consequently if the liquid to be analyzed contains no saline matter, the error may be but trifling, the error in the analysis correcting more or less accurately the original error in the determination of the "titre." This mode of estimation is particularly recommended for determining the quantity of free acid in acid saline solutions, but here is just where it would be most fallible, the nature and quantity of the saline substance in solution exerting a powerful influence on the solubility of the precipitate. It is evident that a solution containing 5 grammes of free sulphuric acid with 5 grammes of sulphate of ammonia, tested in this way, would give quite a different result from one in which 5 grammes of free acid was contained with 20 or 50 of sulphate of ammonia. Likewise its results when used in the "method of residues" must be false. Accordingly in an experimental trial by Dr. Mohr‡ for the determination of magnesia by supersaturation with a known quantity of sulphuric acid, and determination of the residue of uncombined acid, the result which he obtained is erroneous by 4 per cent. Four per cent too little of magnesia were obtained, because the free sulphuric acid was over-estimated, the ammonio-cupric solution having been added till a precipitate was obtained, which as we have just seen, does not fall till *after* the saturation point has been reached.

The precipitate which appears in all these cases is spoken of by Dr. Mohr as hydrated oxyd of copper. It appears to be basic (probably quadrobasic) sulphate.

* Not having a German copy at hand I quote from the French translation made by Forthomme under the superintendence of Dr. Mohr.

† Forthomme's translation, p. 409.

‡ Op. cit., p. 412.

In making these observations on a single process of Dr. Mohr, I wish at the same time to bear testimony as to the candor with which he has given the results of his experimental trials. The proposal of a mode of analysis such as that of Mr. Walker is a new proof how much it is to be regretted that any chemist should offer a new mode of analysis, without having first controlled it by the analysis of one or more specimens of substance of a known composition. In this way MM. Glénard and Guillermond have recently proposed* a method of estimating the quinine in barks. It has been however shown† that not only the presence of cinchonine destroyed the accuracy of these results, but that owing to a mistake of the authors as to the reaction of the sulphates of quinine upon tincture of logwood, the process when performed with pure quinine gave only one-half the true result.

In connection with the foregoing observations on zinc I may remark that an error has crept into the description of zinc reactions in Gmelin's Handbook. It is there stated that zinc salts give precipitates with ferrocyanid and ferridcyanid of potassium, both of which are soluble in chlorhydric acid.‡ As respects the precipitate with ferrocyanid, this is certainly erroneous, the precipitate does not redissolve in that acid.

Philadelphia, Dec. 28, 1860.

ART. XVI.—*On the Dimorphism of Arsenic, Antimony and Zinc;* by JOSIAH P. COOKE, JR.

THE rhombohedral forms of arsenic, antimony and zinc are well known. Those of arsenic and antimony have been determined by several observers,§ and that of zinc first observed by Nöggerath,‖ on a furnace product from the smelting works of the Vieille Montaigne Zinc Co., near Aix la Chapelle, was subsequently redetermined on the same specimen by Gustav Rose.¶ It is the object of the present paper to show that these elements may also crystallize in regular octahedrons and therefore that they are dimorphous. Supposed monometric crystals both of arsenic and zinc have been previously described but since these observations have been discredited, the author has thought it best to publish his results.

Arsenic.—In the "Journal für praktische Chemie," vol. xxii, 344, 1841, Elsner describes, as crystals of arsenic, octahedrons,

* Rep. de Chimie Appliquée, 1859, p. 131. † Idem, 1860, p. 61.

‡ Handbook, vol. v, p. 12, Cavendish edition.

§ See description of a crystal of rhombohedral arsenic, in Proceedings of American Academy of Arts and Sciences, vol. iii, 86.

‖ Poggendorff Annalen, vol. xxxix, 323. ¶ Ibid., lxxxiii, 129.

which he obtained by subliming a mixture of arsenious acid and charcoal powder. The author repeated the experiment of Elsner and obtained very distinct octahedral crystals, having a nearly black color and bright lustre, which were undoubtedly the same as those observed by Elsner. Similar crystals made by subliming the commercial arsenic, "cobalt," in a glass flask were at first sight mistaken by the author for crystals of arsenic. Their true nature however became evident on boiling the crystalline mass in water when it all dissolved with the exception of a small quantity of a black amorphous powder, the amount varying with different specimens. The substance dissolved was easily recognized as arsenious acid, and the black powder as finely subdivided metallic arsenic. The octahedrons were evidently merely crystals of arsenious acid containing as a mechanical mixture, particles of metallic arsenic like the sand in the crystals of Fontainbleau limestone. This result led the author to make a series of experiments with a view of testing the possibility of crystallizing pure metallic arsenic in forms of the monometric system. In one experiment rhombohedral crystals of arsenic, which had been prepared by sublimation in the usual way, afterwards kept under water, deprived of air by boiling, and just before using dried in a current of hydrogen, were introduced into a glass flask. Through this flask which was fitted with a cork and glass tubes for the purpose, a gentle current of hydrogen was maintained, the gas entering at the top and passing out near the bottom of the flask. As soon as the flask was known to be filled with hydrogen, the arsenic was sublimed in this atmosphere, when it condensed around the neck forming the well known metallic mirror. On subsequently breaking the flask and examining the mirror with a microscope (power of eighty diameters) it was found to be studded with distinct octahedral crystals having a greyish color and a bright metallic lustre. These octahedrons were recognized as belonging to the monometric system first by measuring the angles of the triangular faces and finding that they were equilateral triangles, second by the general "habitus" of the crystals especially in their distorted forms which could never be mistaken for truncated rhombohedrons, the only form with which they were liable to be confounded. The crystals were strictly microscopic and could not be distinguished with a pocket lens except as brilliant points. The precautions taken in the preparation seemed to exclude the possibility of any arsenious acid being present, but in order to establish this fact beyond a doubt, a portion of the metallic crust studded with the crystals was boiled in water for several minutes and afterwards treated with the strongest aqua ammoniæ for twenty-four hours, but the crystals were not dissolved by either reagent nor was their sharpness apparently impaired.

In another experiment arseniuretted hydrogen gas was reduced in a bohemian glass combustion tube in the usual way, when testing for arsenic only on a larger scale and with special precaution in order to ensure the exclusion of air from the apparatus, and to regulate the quantity of arseniuretted hydrogen in the current of hydrogen gas. To one end of the combustion tube was connected by a cork a small exit tube whose open end dipped under mercury the other end was connected by means of a tube having two branches each provided with a stop-cock with a hydrogen generator on the one hand and on the other with a gas bottle generating arseniuretted hydrogen. The last was provided with a safety tube by which the excess of gas not needed in the experiment might escape. Before heating the combustion tube it was filled with hydrogen from the generator by which a uniform current of gas through the tube was maintained during the process. A portion of the tube two or three inches long was next heated to a red heat and then by opening the stop-cock a very small amount of arseniuretted hydrogen was allowed to mix with the hydrogen current and the experiment continued until a metallic mirror was formed on the glass beyond the heated portion of the tube. This mirror examined by the microscope, was found to be studded with minute octahedral crystals, which were submitted to the same test as before and with the same results.

Antimony.—No crystals of this metal except the well known rhombohedral forms ever appear to have been observed. Hauy formerly supposed that he had discovered in antimony the four cleavage planes of the regular octahedron and the six cleavage planes of the regular rhombic dodecahedron, but his observations were made on the ordinary regulus of antimony, which is now known to have rhombohedral cleavages. After crystallizing arsenic in octahedron by the process last described the author succeeded in obtaining octahedral crystals of antimony with the same apparatus, using antimonuretted hydrogen in place of arseniuretted hydrogen. The tube was heated with a Bunsen's gas burner to as high a temperature as it was capable of yielding and the process conducted as before. On breaking the tube and examining the metallic mirror with a microscope it was found studded with minute octahedral crystals. They were more readily obtained than the corresponding crystals of arsenic and presented the same characteristic forms. The solid angles of the octahedrons were very frequently observed modified by the faces of the cube and in one case at least the edges were truncated by the faces of the rhombic dodecahedron. These modifications are of importance as they remove all doubt in regard to the system of crystallization. The crystals being microscopic their interfacial angles could not of course be measured, but the

existence of these modifications is even more satisfactory evidence on this point than an actual measurement.

It is well known that oxyd of antimony is capable of crystallizing in octahedrons belonging to the monometric system and although from the construction of the apparatus it was deemed impossible that any sensible amount of air could become mixed with the hydrogen in the tube, yet in order to remove all doubt on the subject, the crystals were exposed to the following reagents.

A portion of the glass tube covered with crystals was first boiled for a long time in water and subsequently treated with the strongest liquid hydrochloric acid; but although exposed to the action of the acid for several days in a warm room, the crystals were not dissolved. They also resisted for some time the action of boiling hydrochloric acid, but after prolonged boiling they disappeared. Exposed to the action of chlorine gas at a very gentle heat, the crystals were immediately consumed, leaving no residue and rendering the gas cloudy from the fumes of chlorid of antimony. Lastly, a portion of the tube (on which was deposited nothing but distinct octahedral crystals), was treated with a few drops of nitric acid, and a gentle heat applied. The crystals were at once attacked and the familiar white powder of antimonious acid was the result. This dissolved on adding a few drops of hydrochloric acid and the solution evaporated nearly to dryness, diluted with a solution of tartaric acid and subsequently treated with a solution of sulphid of hydrogen, gave the familiar red precipitate of sulphid of antimony.

In the metallic mirrors of arsenic and antimony obtained by Marsh's test, the metals seem to be always in the octahedral modification, and when deposited slowly are more or less crystalline. The author has obtained the best crystals by resubliming the metallic mirrors, after they were first formed, in a slow current of hydrogen, and it is in this way very easy to obtain the crystals entirely isolated on the surface of the glass tube, and in the case of antimony the author has traced with the microscope every gradation between the distinct crystals and the granular coating, which forms the mass of the mirror. The process of crystallization in the formation of the mirror is similar to that of sal-ammoniac on a glass plate and the lines of crystals shoot out in the same way parallel to the axis of the tube.

Zinc.—In the "Annales de Chimie et de Physique," vol. xxii, 37, 1848, Nicklès has described some crystals of pure zinc prepared by M. Favre with the process of M. Jacquelain as pentagonal dodecadrons but unfortunately he has given no measurement of angles to confirm his opinion. This observation has been questioned by Gustav Rose* on the grounds first that the

* Poggendorff, Annalen, vol. lxxxv, 293.

mamillary concretions of zinc, which are frequently deposited on the cooler portion of the retort during the process of distillation might readily be mistaken for pentagonal dodecahedrons without any exact measurement of angles, and secondly that this form which is characterized by a peculiar law of symmetry, has never been observed unless this case is an exception, on any metallic crystals. The question might readily be settled by a reëxamination of the original specimen and it is to be hoped that, if they still exist, such an examination will be made.

In "Poggendorff's Annalen," vol. cvii, 441, 1859, Gustav Rose has described two specimens of crystallized brass formerly belonging to the mineral collection of Klaproth, which show in the cavities of the mass distinct crystals. Rose infers that these crystals belong to the monometric system rather from their grouping as indicated by the striation than from the external forms of the individual crystals which was too indistinct to admit of exact determination. This subject has been much more fully studied by Mr. F. H. Storer in the laboratory of Harvard College. Storer obtained octahedral crystals composed of zinc and copper in the varying proportions of the constituents from pure copper to 70 per cent of zinc.* The crystals were made by fusing the metals in a crucible and pouring out the still liquid alloy after a crust had formed on the surface as in crystallizing bismuth or sulphur. They were all too ill-defined to admit of direct determination and although they exhibited similar striations to those described by Rose, the striæ did not seem to the author to fix the system of crystallization with such clearness as to exclude all doubt. There were however other circumstances which were thought to point out the system of the crystals; first, the crystals resembled precisely the artificial crystals of magnetic oxyd of iron which are frequently obtained as a furnace product, and which are known to belong to the monometric system. The author had recently the opportunity of comparing with the brass crystals a very finely characterized specimen of this magnetic oxyd in the mineral collection of Dr. Krantz at Bonn. Second, the whole series of crystals including those of pure copper had the same characters and if the crystals of copper were monometric, as no one will question, the rest are also. But assuming that the octahedrons in question are monometric, this fact has no bearing upon the crystallizing form of zinc unless it can be also shown that there is no definite chemical combination between the zinc and the copper, or in other words, that the alloys of those metals are nearly isomorphous mixtures. Storer has proved this point as the author thinks, conclusively, by analyzing the series of crystals as well as the alloys in which they were formed. The full details of his results will be found in his

* See an abstract of Storer's paper at the close of this Number.

memoirs in vol. vi, of the Memoirs of the American Academy of Arts and Sciences. It is sufficient for the present purpose to state that the composition of the crystals was in every case sensibly the same as that of the alloy.

This investigation seems to prove that zinc is capable of assuming a monometric condition and thus of crystallizing in connection with copper in the same way that sulphate of copper may be made to crystallize in connection with sulphate of iron, taking the form of green vitriol although it generally assumes the form of another system. But although his results are conclusive as far as they go, Storer could not obtain crystals containing more than 70 per cent of zinc. The alloys of zinc and copper containing more than this per cent of zinc become granular on cooling, and do not yield distinct crystals. The following observations of the author may therefore be of value in extending the history of the subject.

During the course of some experiments on the compounds of zinc and arsenic a furnace product was accidentally obtained composed of these two elements imperfectly fused together and mixed with cinders. The cavities of this mass were lined with very brilliant octahedral crystals having a bright metallic lustre. The crystals although small could be easily measured with a reflective goniometer and gave the exact angle of the monometric octahedron. A sufficient number of the crystals for analysis was separated with some difficulty from the gangue. They were dissolved in dilute hydrochloric acid and the zinc precipitated with carbonate soda was determined in the usual way. The result gave

Zinc,	81·18
Arsenic,	18·82
	100·00

The quantity of arsenic in these crystals is so much smaller than the amount required to form any probable definite compound that there can be but little doubt that it is present as impurity and that the octahedrons are an isomorphous mixture of the two elements. The presence of a certain amount of impurity seems to favor metallic crystallization and it is possible that it may be the disposing cause in this case, inducing as it were a monometric condition in the zinc. The beautiful lead crystals containing a small quantity of antimony which are obtained at the smelting works near Clausthal in the Harz, are familiar to mineralogists, and the author has found that a small quantity of lead on the other hand greatly facilitates the crystallization of antimony. Similar facts have been noticed in the case of bismuth so that distinct crystallization instead of being the test of purity in the case of a metal is quite the reverse. To what extent the presence of these impurities may effect the crystalline form of the metal

has not yet been determined but it is certain that this influence is important and that it depends as well on the amount as on the nature of the impurity. Laurent and Holms (Ann. de Chimie et Phys., [2], vol. lx, 333), state that zinc containing a few per cent. of iron crystallizes in rhombic prisms, and Warren de la Rue also (Philosophical Magazine, vol. xxvii, 370) has analyzed and measured rhombic prisms of zinc having the composition, zinc 90·00, iron 2·56, lead 6·00, copper 1·44. Acicular crystals having a similar composition have also been described by Erdmann, (Berzelius, Traité, ii, 620). Moreover the author observed in a furnace product similar to the one above described some flexible acicular crystals which he analyzed and found to consist of zinc 91·3, arsenic 8·7. These crystals could not be crystallographically determined but they were undoubtedly similar in form to those before described and entirely different from the octahedral crystals noticed above. Is it not possible that all the prismatic crystals of zinc, which have been described, including those of Nöggerath and Rose, may belong to the same crystalline system? If so the apparent anomaly presented by the above facts would disappear, and as the observers themselves do not claim that the crystalline system has in either case been determined beyond a doubt, this is not an improbable supposition; moreover the authority for the rhombohedral system rests on a single specimen, which, as Rose admits, is not capable of exact determination crystallographically and has never been analyzed. However these facts may be regarded, the octahedral crystals above described appear to the author to confirm the view that zinc is capable of crystallizing in the monometric system, but he does not attach to the observation any weight except as confirming previous results, and as furnishing additional data for the solution of the problem.

Cambridge, Nov. 14, 1860.

ART. XVII.—*General Account of the Results of Part* II. *of the discussion of the Declinometer Observations made at the Girard College, Philadelphia, between* 1840 *and* 1845, *with special reference to the Solar Diurnal Variation and its Annual Inequality;* by A. D. BACHE, Superintendent U. S. Coast Survey.

(Read before the Amer. Assoc. for the Adv. of Science, at Newport.)

THE discussion presented last year to the Association embraced the amplitude of the solar diurnal magnetic variation, as well as that of the number and magnitude of the disturbances of declination, in reference to the eleven years' period, heretofore pointed out by General Sabine and others. The discussion now presented, is of the annual solar diurnal variation and its annual

inequality. The complete results of the computations, as in the other case, will be given in the Smithsonian Contributions to Knowledge, and the present paper will contain merely a general account of the results.

The normals, or means, freed from the disturbances, are used in the discussion, avoiding thus the necessity for rejecting the observations of months in which disturbances are frequent. The same course is followed by the Rev. Professor H. Lloyd in his discussion of the Dublin observations and also by General Sabine in the third volume of the discussion of the Toronto observations. I therefore return to the hourly normals given in part (I.)* of the discussion, and arrange them according to months of the year, correcting those of 1845 for index error, as already explained. The tables given in the complete memoir, show at one view the mean hourly readings for each month unaffected by large disturbances, and the mean hourly position of the magnet in reference to its general mean position. The solar diurnal variation for each month is readily traced in the table, but the annual inequality in the diurnal variation being affected by the secular changes is less distinctly traceable. To give this result distinctness, each hourly normal is compared with the corresponding monthly mean value, as set down in the last vertical column of the table, and the results are recorded in a new table. The sign + in this latter table indicates a westerly, and the sign − an easterly deflection of the north end of the magnet from its mean position, the scale divisions having been converted into minutes of arc.

The distinctive features of this second table are brought out both analytically and graphically. The inequality in the diurnal variation is most readily seen by comparing the horizontal lines of the table from August and February and the annual variation appears most plainly by carrying the eye down the vertical columns for the hours of 6 and 7 A. M.

The annual variation depends upon the earth's position in its orbit, the diurnal variation being subject to an inequality depending upon the sun's declination. The range is greater during the summer, when the declination is north, and less during the winter when the declination is south, and passes from one to the other about the time of the equinoxes. The summer and winter means are therefore tabulated for comparison with the general mean. Diagram A shows the type curve for the summer and winter periods and the general mean of the year. The summer months, April to September inclusive, give a diurnal range of nearly $10\frac{1}{2}$ minutes and the winter months one of $5\frac{1}{2}$ minutes. Diagram B shows the same results in a different form, the mean yearly curve of the first diagram (A) being straightened out to form the axis of the second (B). The curves represent the win-

* This Jour., [2], vol. xxix, p. 36.

ter and summer variations, the ordinates being the difference between those of the yearly curve, and of the winter and summer curves respectively. This diagram shows very perspicuously the progress of the annual variation at different hours of the day. It shows that at 6 or 7 A. M. the annual variation is a maximum, disappearing at a quarter before 10 A. M. That it reaches a second, (secondary,) maximum at 1 P. M. nearly disappearing shortly after 5 P. M. A still smaller maximum is reached after 9 P. M. and half an hour before midnight the annual variation again disappears. At, and before, and after the principal maximum between 6 and 7 A. M. the annual variation causes the north end of the magnet to be deflected to the eastward in the summer and to the westward in the winter. At 1 P. M. the deflections are to the west in summer and to the east in winter; the range of diurnal motion being thus increased in the former season and diminished in the latter. The needle is thus deflected in summer, more to the east in the morning hours and more to the west in the afternoon hours, or has greater elongation than it would have if the sun moved in the equator. In winter the reverse is the case. The range of annual variation from summer to winter at Philadelphia is about 3′, and its daily range about 2′·6.

In diagram C similar curves are given for Philadelphia, St. Helena, Toronto and Hobarton, of the winter and summer progress of the annual variation. The comparison indicates that Toronto and Hobarton are not normal types of the half yearly deflections and the near coincidence of the forms at Philadelphia and St. Helena, seems to show that the type for different places is one and the same in general character, affected by incidental irregularities.

In reference to the annual variation, Gen. Sabine, in the rectifications and additions to the last volume of Humboldt's Cosmos, expresses himself as follows:

"Thus in each hemisphere the semi-annual deflections concur with those of the mean annual variation for half the year and consequently augment them, and oppose and diminish them in the other half. At the magnetic equator, there is no mean diurnal variation, but in each half year the alternate phases of the sun's annual inequality constitutes a diurnal variation of which the range in each day is about 3′ or 4′, taking place every day in the year, except about the equinoxes, the march of the diurnal variation being from east in the forenoon to west in the afternoon when the sun has north declination and the reverse when south declination." According to the same authority the *annual* variation is the same in both hemispheres, the north end of the magnet being deflected to the east in the forenoon, the sun having north declination, whereas in the *diurnal* variation the north

end of the magnet at that time of the day, is deflected to the east in the northern hemisphere and to the west in the southern; In other words, in regard to direction, the law of the annual variation is the same as that of the diurnal variation, but opposite in passing from the northern to the southern magnetic hemisphere.

Some interesting conclusions as to the law of change of the annual variation, will flow from a closer discussion of the observations at the two hours of maximum, namely 6 to 7 A. M. and 1 to 2 P. M. The general table, by subtracting the annual mean from each monthly value, at the respective hours, gives the following values for the annual variations at or near the hours of principal and secondary maxima of range, the signs + and − indicating as usual westerly, or easterly deflection from the annual mean position.

	6 to 7 A. M.	1 to 2 P. M.		6 to 7 A. M.	1 to 2 P. M.
	′	′		′	′
January,	+2·01	−0·98	July,	−1·94	+1·25
February,	+1·31	−1·12	August,	−2·66	+1·31
March,	+0·47	−0·47	September,	−1·24	+0·82
April,	+0·15	+1·06	October,	+1·41	−1·14
May,	−1·38	+0·93	November,	+1·47	−1·35
June,	−1·90	+0·89	December,	+2·30	−1·20

The greatest range at 6 to 7 A. M. is 5′·0 the easterly deflection being greater than the westerly by 0′·4. That from 1 to 2 P. M. is 2′·7, the eastern and western deflections being equal. A general inspection of the columns shows that the solstices are approximately the turning epochs of this annual variation, and that the signs change at the time of the equinoxes. To determine these points with the more precision the numbers of the table were expressed by an analytic formula. According to this, January 1st and July 1st (ten days after the solstices) are the dates of the greatest values, and the transition from positive to negative values, and the reverse will occur on the first of April and first of October (ten days after the equinoxes).

A table is given in the memoir showing the satisfactory coincidence of the observed and computed values. This result agrees with that deduced by a different method by General Sabine.

To give a definite determination of the law of the phenomenon, so as to embrace the whole progress shown by the series, the regular solar diurnal variation has been expressed as a function of the time, by four terms of Bessel's formula, the equation being found for each month, and also for each half year from April to September and from October to March and also for the whole year. Allowance was made in determining the coefficients for the different weight of the readings at the even and at the odd hours.

The equation for the whole year is compared with that given by Prof. Lloyd for Dublin. Reference is made to the monthly equations deduced by Mr. Karl Kreil from a consecutive series of observations made at Prague from 1840 to 1849, and selected from a longer series of thirteen years.

The following table exhibits the close correspondence of the computed and observed mean annual value of the regular solar diurnal variation.

Philadelphia mean time.	Diurnal variation. Compared.	Diurnal variation. Observed.	Difference.	Philadelphia mean time.	Diurnal variation. Compared.	Diurnal variation. Observed.	Difference.
h *m*				*h* *m*			
0 19½	−0·49	−0·47	−0·02	12 19½	+3·69	+3·65	−0·04
1 "	−0·48	−0·51	+0·03	13 "	+4·28	+4·32	+0·04
2 "	−0·51	−0·44	−0·07	14 "	+3·81	+3·77	−0·04
3 "	−0·67	−0·71	+0·04	15 "	+2·77	+2·76	−0·01
4 "	−1·09	−1·19	+0·10	16 "	+1·71	+1·80	+0·09
5 "	−1·82	−1·64	−0·18	17 "	+0·88	+0·78	−0·10
6 "	−2·77	−2·72	−0·05	18 "	+0·33	+0·25	−0·08
7 "	−3·49	−3·47	−0·02	19 "	−0·07	−0·07	−0·00
8 "	−3·44	−3·50	+0·06	20 "	−0·38	−0·33	−0·05
9 "	−2·29	−2·43	+0·14	21 "	−0·57	−0·60	+0·03
10 "	−0·24	−0·19	−0·05	22 "	−0·62	−0·64	+0·02
11 "	+2·08	+2·17	+0·14	23 "	−0·57	−0·71	+0·14

The greatest difference at any one hour is less than 11″ and the probable error of any single computed value is ±0″·19.

Diagrams D and E give the resulting curves for the computed hourly values of the diurnal variation for each month of the year. Diagram D contains the curves for the six months of the summer half year and E, for six months of the winter half year. Positive ordinates correspond as before to a westerly motion of the north end of the needle, and negative ordinates to an easterly motion. Diagram F contains the type curves for the summer, winter and the whole year.

From the computed values as given in the the table assisted by the diagrams, the general features of the diurnal variation and of its annual inequality are readily deduced.

The general character of the diurnal motion is nearly the same for the summer half year, for the winter half and therefore for the whole year. The greatest eastern deflection is, at a mean, reached a quarter before eight A. M. being a quarter of an hour earlier in summer, and half an hour later in winter. Near this hour the declination is a minimum. The greatest western deflection is reached, at a mean, at a quarter after one o'clock P. M., a few minutes earlier in both the summer and winter. At this hour the declination is a maximum. The diurnal curve presents but a single wave, slightly interrupted by a deviation occurring during the hours near midnight, or from 10 P. M. to 1 A. M. when the magnet has a direct or westerly motion. Shortly after 1 A. M. the north end of the magnet moves easterly, completing the

cycle, and arriving at its eastern elongation shortly before 8 A. M. This nocturnal deviation is well marked in winter, vanishes in summer and is but slightly perceptible in the annual curve. According to the investigations of General Sabine, it is probable that if the effect of disturbances was completely obliterated in the results, this small oscillation would disappear. In summer when it is not noticed the needle remains nearly stationary from 8 P. M. to 3 A. M. The type curves for the year, show a similar result. The diurnal curves for the months when the sun's declination is north, and those when it is south, resemble each other closely, as is shown by diagrams D and E.

For greater precision in regard to the epoch and amount of the diurnal variation we must recur to the analytical expressions representing the numbers of the table.

The following table contains the results for each month and for the summer and winter seasons and the whole year, also the critical interval between the two adjacent hours of the mean positions.

Month.	Eastern elong. A. M.	Western elong. P. M.	Critical interval from min. to max.	Epoch of mean declination.		Critical interval.
				A. M.	P. M.	
	h m	h m	h m	h m	h m	h m
January,	8 58	1 27	4 29	10 52	7 08	8 16
February,	8 34	1 32	4 58	10 52	7 26	8 34
March,	8 07	1 34	5 27	10 46	7 32	8 46
April,	8 12	1 27	5 15	10 34	7 40	8 56
May,	7 29	1 21	5 52	10 19	6 57	8 38
June,	7 33	1 20	5 47	10 25	8 26	10 01
July,	7 36	1 28	5 52	10 30	9 32	11 02
August,	7 18	1 05	5 47	10 10	8 40	10 30
September,	7 30	0 45	5 15	9 58	6 45	8 47
October,	8 00	1 17	5 17	10 30	5 23	6 53
November,	7 54	1 08	5 14	10 16	6 08	7 52
December,	8 54	1 40	4 46	10 50	6 17	7 27
Summer,	7 33	1 08	5 35	10 17	7 43	9 26
Winter,	8 24	1 25	5 01	10 40	6 49	8 09
Year,	7 48	1 16	5 28	10 26	7 08	8 42

The formulæ also give for the time of the seondary minimum of eastern declination in winter $9^h\ 42^m$ P. M. and for its amount $-0'{\cdot}97$.

For the time of the secondary maximum of western declination in winter, $1^h\ 15^m$ A. M., and for its amount $-0'{\cdot}26$; differences $3^h\ 33^m$ and $0'{\cdot}71$.

For the secondary minimum of eastern deflection for the year, $10^h\ 11^m$ P. M. and its amount, $-0'{\cdot}62$.

For the secondary maximum of western deflection for the year, $1^h\ 13^m$, and its amount $-0{\cdot}47$; differences $3^h\ 02^m$ and $0'{\cdot}15$.

The effect of the season on the critical hours is well marked in the foregoing table, the eastern elongation occurring earliest between the summer solstices and the autumnal equinox, and latest about the winter solstice.

The eastern elongation occurs earliest about the winter solstice and the same holds good for the morning epoch of the mean declination. The afternoon epoch, however, occurs earliest shortly after the autumnal equinox, and latest shortly after the summer solstice. The critical hours which are most constant during the year, are those of the western elongation and of the morning mean declination. The greatest difference between any month and the mean of all the months, is 31 minutes in the former and 28 in the latter.

To exhibit the features of the diurnal variation and its annual inequality, a graphical representation is given in diagram G. The magnetic surface is formed by contour lines 0′·5 apart. The curves in dots (....) are lines of mean position. Those in dashes (- - - -) are eastern deflections from the normal position and the full lines are western deflections. This Diagram and the table from which it is deduced are immediately applicable to the practical problem of furnishing the correction to be applied to a single observation, made at any hour of the day and month, to reduce it to its mean value. It also renders unnecessary the development of the annual variability of the coefficients in the analytical expression. The diagram distinctly exhibits the diurnal minima and maxima, the former represented by a valley, the latter by a ridge, on the magnetic surface.

Next, the magnitude of the diurnal range is studied. The following table exhibits the amount of the deflection at the eastern and western elongation and the diurnal amplitude of the declination for each month in the year derived from the equations.

	Deflection at E. Elong.	Deflection at W. Elong.	Diurnal range.		Deflection at E. Elong.	Deflection at W. Elong.	Diurnal range.
Jany.	−2′·46	+3′·52	5′·98	July.	−5′·58	+5′·46	11′·04
Feby.	−2 ·64	+3 ·11	5 ·75	Aug.	−5 ·79	+6 ·36	12 ·15
March.	−3 ·73	+4 ·03	7 ·76	Sept.	−4 ·71	+5 ·60	10 ·31
April.	−4 ·02	+5 ·28	9 ·30	Oct.	−2 ·18	+3 ·23	5 ·41
May.	−4 ·89	+5 ·16	10 ·05	Nov.	−1 ·92	+2 ·85	4 ·77
June.	−5 ·26	+5 ·06	10 ·32	Dec.	−1 ·65	+3 ·14	4 ·79

The diurnal range for the summer months is 10′·45, for winter months 5′·56, and for the whole year 7′·89, all corresponding to an epoch about a year and a half removed from the epoch of a minimum of the solar period.

The numbers denoting the diurnal range, exhibit three remarkable features, namely, the maximum value in August, the sudden falling off in September and October, (Diagram H,) and the minimum value in November and December. In other respects, the progression is regular. The curve is single crested, which holds in the eastern, as well as the western deflections when viewed separately. This is of special importance, as it is probable that the interference of these separate curves at other

stations chiefly determine the double crested character of the curves of diurnal range. The curves for Milan, Munich, Göttingen, Brussels, Greenwich, Dublin, etc., for instance, exhibit two maxima, one after the vernal equinox and a second, generally the smaller, about the summer solstice. The system to which Philadelphia belongs, is exemplified by the annual progress of the diurnal range at Prague and certain Russian stations, as at Nertschinsk, but more closely by Toronto as seen in Diagram H. Neither station appears to have a tendency to a secondary maximum about the month of April, so that the maximum about a month and a half after the summer solstice, is a well marked feature of the North American stations.

In connection with the preceding discussion the inequality in the magnetic declination from year to year next claims attention.

This subject presents greater inherent difficulties than the diurnal inequality, on account of the difficulty of keeping the instrument in precisely the same condition of adjustment throughout the year. In the first part of the discussion, I had occasion to refer to this circumstance while investigating the annual effect of the secular change, and it was then shown that the Philadelphia observations share in this respect a similar difficulty with other stations in consequence of which the results must be received with caution.*

In the mean monthly values of the declinometer readings and in their differences, when compared month for month, are combined the joint effect of the secular change, and of the annual inequality. To eliminate the effect of the secular change, conditional equations were formed, which give a value deduced by the application of the method of least squares, of 1·227 divisions, as the monthly effect of the secular change.† The effect of the secular change was deduced from the mean monthly values, and these values themselves being subjected to certain corrections, which the numbers show to be necessary, the following result for the annual inequality was obtained.

* Dr. Lloyd's instructive note on this subject in his discussion of the Dublin observations is as follows: "The determination of the annual variation is much more difficult than that of the diurnal, both on account of the much smaller frequency of the period and the difficulty of preserving the instrument in the same unchanged condition during the much longer time, or of determining and allowing for its changes when they do occur; accordingly, although the annual period may be traced in the observations of Gilpin and is decidedly displayed in those of Bowditch, it has evaded the researches of recent observers. There is but a faint indication of its existence in the Göttingen observations, which were made at the hours of 8 A. M. and 1 P. M., and Prof. Gauss and Dr. Goldsmith, find in the analysis of these observations no important fluctuations dependent upon season. A similar negative result is deduced by Dr. Lamont from the Munich observations which were made twelve times a day.

† This value 6′·7 of annual change, though not preferable to the value (4′·5) deduced by a different method in part I of this discussion, must necessarily be employed in the present investigation. The most reliable value 5′·0 was deduced from independent observations, as already announced.

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean declinom. readings,	56·7	563·1	563·5	562·6	561·1	562·2	562·1	561·2	558·4	558·1	554·6	554·4
Corr. for secular change,	−4·4	−3·6	−2·8	−2·0	−1·2	−0·4	+0·4	+1·2	+2·0	+2·8	+3·6	+4·4
Annual variation in arc,	+0·5	+0·4	−0·1	−0·1	+0·2	−0·6	−1·0	−0·9	0·0	−0·2	+0·9	+0·7

This result has been adopted as representing the annual variation. From June to October the north end of the magnet is accordingly to the eastward of the mean annual position, (after the elimination of the secular change,) and in the remaining months of the year, it is to the westward of this position. From the vernal equinox until after the summer solstice, the motion is to the eastward, or retrograde in regard to the advance of the secular change, (to the westward). This is in conformity with the law given by Dr. Lloyd in the Dublin discussions, the motion of the magnet there being to the westward at that period of the year, or the reverse of the Philadelphia deflection. The secular change is also reversed. The west declination diminishing at Dublin between 1840 and 1843. The results for annual inequality from seven years of observation at Toronto, are also brought out and compared with the Philadelphia results. The secular change at Toronto was 2′0, whilst at Philadelphia (1843) it was 4′4. In regard to the amount of the inequality, the two stations agree remarkably well, the range remaining slightly below 2′ of arc. It is supposed that this range at the same station is increasing, or diminishing, as the secular change increases or diminishes.

ART. XVIII.—*The Upper Silurian Beds of Western Tennessee; and Dr. F. Roemer's Monograph;* by Prof. J. M. SAFFORD, Lebanon, Tenn.

To no part of Tennessee has the attention of American palæontologists been more frequently directed than to the region of "the glades," in the western part of the State. Recently attention has again been called to this region by the publication of Dr. Roemer's valuable and elegant monograph.* For this work, which we welcome with great pleasure, we are much indebted to Dr. Roemer. It presents a unique local fauna of great interest. Setting aside a few forms, the species he enumerates and describes belong to a bed of calcareous shales and limestones equivalent to the Niagara group of New York. This bed I have denominated for some time past, in my unpublished notes, the 'sponge-bed,' or the sponge-bearing bed, the appropriateness of which name is at once seen by referring to Dr. Roemer's monograph.

* Die Silurische Fauna Des Westlichen Tennessee; Eine Palæontologische Monographie von Dr. Ferdinand Roemer; Breslau, 1860. See this Journal, xxxi, 127.

The object of this article is to point out the fact that the fauna illustrated in the above work is not the only one occurring upon the glades. Heretofore not a little confusion has existed with reference to the different beds of this region. To this day, so far as the writer knows, no complete sections have been published. To present the number and order of the beds, and to prepare the way for a clear understanding of the formations and their condition, the following section, selected from the materials gathered for my Report upon the Geology of Tennessee, is given. It was made in the northern part of Wayne county. The successive beds crop out along a line, which commencing at the level of the Tennessee river (low water) at Clifton, and running back nearly four miles, terminates at the top, and on the end of one of the spurs, or fingers, that jut out from the high flat lands further east. The beds are arranged in descending order. The term Niagara is made to include both the Clinton and Niagara groups of New York.

Carboniferous.		9. Top of ridge overlooking the valley of Eagle Creek. Strata concealed; loose cherty masses scattered over the surface containing occasional fossils, 53 feet.
Devonian, *Hamilton group?*		8. Strata (when weathered) *bluish or greenish siliceous shale.* Eight feet at the base interstratified with thin, smooth, fine-grained sandstones which are charged with individuals of a small *Lingula*, 42 feet.
		7. *Fine-grained sandstone* highly charged with the same *Lingula* as above, 8 feet.
Upper Silurian.	*Lower Helderberg?*	6. *Grey crinoidal Limestone*—Fossils obscure at this point,—the horizon, however, of well marked Lower Helderberg rocks at other points in Wayne county, 25 feet.
	Niagara, the Sponge-Bearing Bed.	5. *Glade-forming Limestones and Calcareous Shales.*—The limestone grey often coarse crinoidal—sometimes argillaceous—All very fossiliferous—occasionally containing layers of chert, 90 feet.
	Niagara, the Variegated Bed.	4. *Variegated Limestone;* brownish-red and grey layers interstratified—many layers argillaceous—*orthocerata* abundant in lower part, 96 feet.
Lower Silurian. *Hudson River.*		3. *Greenish calcareous Shale,* containing *Leptæna sericea,* and *Strophomena alternata,* 15 feet.
		2. *Blue Limestone* in rough thick-bedded layers containing *Strophomena alternata, S. tenuistriata, Rhynconella increbescens, R. dentata,* Cyclonema bilix, Columnaria stellata, &c., 21 feet.
		1. *Blue fine-grained Limestone*—in thin smooth layers separated by shaly leaves—has been used as "Hydraulic Limestone"—contains *Orthis testudinaria, Rhynconella modesta, Lingulæ, Trilobites,* &c., 70 feet.

The beds numbered 4, 5, and 6, represent all the glade-forming limestones and shales, and it is to these that attention is especially invited. In this part of Wayne county, their entire thickness is seen to be 211 feet.

No. 4. *Variegated Limestone.*—This bed, the first I notice, rests directly upon the Hudson river rocks. The junction is well seen at Clifton and below that place, for several miles, along the eastern bank of the Tennessee river. This bed is seen in the glade region occupying generally a low position. Outside of Wayne and Hardin counties its base is rarely seen. The vicinity of Clifton is the most favorable place for studying the entire bed, that has come under my observation.

It is easily recognized by interstratified brownish-red layers, some of which, when crinoidal, furnish a pretty good marble. It is, however, often argillaceous and crumbling.

Its red color, due to sesquioxyd of iron, may indicate its Clinton affinities.

This bed is, in general, comparatively barren in fossils. Occasionally its layers are crinoidal. *Atrypa reticularis*, and several species of *orthocerata* are met with. At Clifton, the base of the bed, the entire mass, is exceedingly rich in individuals of several species of *orthoceras* and in large crinoidal stems and roots. The sponges especially are abundant.

No. 5. *Gray Limestones and Shales*, or the *Sponge-bearing Bed.*—This is the division to which Dr. Roemer's fauna belongs. It is a series of gray crinoidal limestones and calcareous shales, the latter often predominating. On the sloping marly glades the layers of limestone frequently crop out in two or three successive ledges separated by masses of shale. Thin layers of chert often occur interstratified with the limestone. Fossils abound, among them *Astraeospongia meniscus* is very characteristic, in fact the mass might well be called the *Meniscus bed.*

The general thickness of the bed is from 80 to 100 feet. In this respect, however, it is quite variable; at a few points the thickness is reduced to 30 and even to 20 feet. In the section above it is given at 90 feet; it is quite possible, however, that a portion of the overlying bed (as in it, at this point, no characteristic fossils were observed) ought to be included, thus making the thickness to a small extent greater.

The *Sponge-bearing Bed* is the prevalent rock of the glades in Hardin, Wayne, Decatur and Perry counties. It also occurs, to some extent, in Humphreys, Benton and Henry.

Nearly all of the species given by Dr. Roemer in his monograph are found in this bed. There are a few, however, which, so far as my observations extend, are confined to the bed next above, having been seen, *in place*, only in these rocks; the most important, perhaps, is *Pentamerus galeatus. Spirifer macropleura*, (*S. Niagarensis*, var. *oligoptycha* of the monograph) although in New York a Lower Helderberg form, is properly included in this fauna as it occurs in this as well as in the overlying bed. *Calceola Tennesseensis*, Roemer, is the same as *C. Americana*,

Safford, described in a previous number of this Journal, (vol. xxix, p. 248). The latter name must give place to the former. On a future occasion I shall have remarks to make upon other species given in Dr. Roemer's monograph.

No. 6. *Lower Helderberg.*—We come now to a bed of strata presenting a fauna quite different from that illustrated by Dr. Roemer. It occurs well marked at numerous points within the glade region and in the counties mentioned. The place of this bed is immediately below the Devonian shales and sandstones cropping out, when present, from beneath those on the hill-sides. At many points it is the surface rock. Many of the glades, with naked summits, present only Niagara rocks. Some, however, are capped by this formation. This division, as a bed, and looking over the whole region, is to a considerable extent cut up and fragmentary.

In thickness it varies much; at some points it is entirely absent, No. 7 or 8 resting immediately upon the Sponge-bearing bed; then again it swells out to 60 or 70 feet, and perhaps to as much as 100 feet although I have not any where, as yet, measured so great a thickness.

So far as it regards the particular section presented, it is not certain that No. 6 is wholly, or even in part, Lower Helderberg, no characteristic fossils having been seen. It marks, however, the horizon of these rocks. Within a few miles of this point, the bed holding this position is well characterized in good sections.*

To my mind it is evident, that this bed was subjected to very considerable denudation before the deposition of the Devonian shales and sandstone; hence its variable thickness, or its absence when, in complete sections, the latter rocks are present. Going further back, I have reason to think that the floor of Niagara rocks, upon which this bed rests, was also previously subjected, (but not in so great a degree,) to denudation, and hence the varying thickness of the Niagara bed. This, too, will explain what appears to be the fact, that where the Niagara bed is thin the other becomes thicker, the two in this respect being, to a certain extent, complementary to one another. The Helderberg sediments filled up the hollows and basins of the partially denuded Niagara floor.

Lithologically the bed under consideration cannot easily be distinguished from the one below it. But its fossils, as a whole,

* I take this opportunity of expressing my thanks to my friend and former pupil, A. B. Gant, Jr., of Cravens Mills, Wayne county, for valuable assistance rendered me in my investigations on Indian and Eagle creeks. Mr. Gant has discovered several most interesting localities of fossils in both Wayne and Hardin counties. His ability and zeal promise much more with reference to the interesting geological features of this region.

are quite different. Here the characteristic sponges of the Niagara bed disappear; and so do the crinoidal forms so well illustrated by Dr. Roemer.

In their places we have other species, mostly brachiopods, the larger portion of which are known to occur in the Lower Helderberg rocks of New York. Below is a list of some of the described species. These have all been collected by the writer from the bed in question. Most of them may be found in all, or nearly all the counties bordering the Tennessee river. With the exception of the last, they have all been compared directly with New York specimens.

Eatonia (Atrypa) singularis.
Merista (") laevis.
" (") bella, Hall.
Rhynchospira formosa, Hall.
" globosa, Hall.
Nucleospira ventricosa, Hall.
" concentrica, Hall.
Pentamerus Verneuili, Hall.
" galeatus, Hall.
Rhynchonella mutabilis, Hall.
Orthis subcarinata, Hall.
" oblata, Hall.
" varica, Hall.
Spirifer perlamellosa, Hall.
Strophomena punctulifera, Conrad.
Phacops Hudsonicus, Hall.
Anisophyllum Agassizi, Edwards and Haime.

Dr. Roemer's beautiful species, *Rhynchonella Tennesseensis*, as well as *Athyris tumida*, as he has it, ought perhaps to be included in the Lower Helderberg fauna; I have seen many perfect individuals of the first in these rocks, and but a few uncertain fragments in the debris of the Niagara, or Sponge-bed; of the second species, but few individuals have come under my observation and I am more in doubt as to its true position.

The following among the brachiopods given in the monograph are common to the two beds; Atrypa reticularis, Rhynconella Wilsoni, Orthis elegantula, Spirifer ("Niagarensis") macropleura and Strophomena depressa.

Within a few months I hope to be able to present a more detailed and systematic account of these rocks, together with complete lists of the fossils they contain.

Lebanon, Tenn., January, 1861.

ART. XIX.—*Correspondence of* JOACHIM BARRANDE, SIR WILLIAM LOGAN *and* JAMES HALL, *on the Taconic System and the age of the Fossils found in the Rock of Northern New England, and the Quebec Group of Rocks.*

I. INTRODUCTORY REMARKS.

As some of our foreign readers may not be acquainted with the question to which the following important correspondence relates, we think it advisable to make a few explanatory observations by way of introduction. A complete history of the whole subject would require a greater amount of space than can be afforded and we shall therefore touch only upon a few of the more salient points.

The rocks under discussion occupy a belt of country east and west from twenty to sixty miles wide, stretching from the vicinity of the city of New York in a northerly direction to Lake Champlain and thence through Vermont and Lower Canada to Cape Gaspé at the mouth of the St. Lawrence. The strata consisting of slates, limestones, sandstones and conglomerates are greatly disturbed, plicated and dislocated, and are often, especially along the eastern side of the belt, in a highly metamorphic condition. On this side they are overlaid unconformably by upper Silurian and Devonian rocks, but on the western and northern margin they are in contact with and in general seem to be a continuation of the Lower Silurian. Some of the slates of the formation closely resemble in lithological characters those of the Hudson River group and thus along the western side of the region, where the junction of the two formations occurs, it is often almost impossible to draw the line between them. The dip and strike of both are in the same direction and throughout extensive areas the newer rocks appear to plunge beneath the older. The whole district affords an excellent example of those cases, so well known to field geologists, where the true relations of the different masses cannot be clearly worked out without the aid of fossils and where the best of observers may arrive at diametrically opposite opinions.

Dr. Emmons, one of the geologists of the New York Survey, early convinced himself by a careful examination of these rocks, that they constituted a distinct physical group more ancient than the Potsdam sandstone, the latter being regarded by him as the base of the Lower Silurian System in North America. His views were given in detail in 1842 in his final report on that part of the State confided to his charge, and in a more special manner in another work entitled "THE TACONIC SYSTEM," published in 1844. In this latter work he figured several species of fossils which had been collected in different parts of the formation. Two of these were trilobites and were described under

the names of *Atops trilineatus* and *Elliptocephala asaphoides*. The others were graptolites, fucoides and apparently trails of annelides; he considered all the species to be distinct from any that had been found in American rocks of undoubted Silurian age. The pre-silurian age of the formation has also been maintained by him in several more recent publications such as his "American Geology"—the several reports on the geological survey of North Carolina and in his "Manual of Geology."

On the other hand, Professor Hall placed the whole region in the Hudson River group. In the first volume of the Palæontology of New York he identifies *Atops trilineatus* with *Triarthrus Beckii* the characteristic trilobite of the Utica slate;—*Elliptocephala asaphoides* he refers to the genus *Olenus* and describes as congeneric therewith another trilobite (*O. undulostriatus*) said to be from the true Hudson River shales. It is scarcely necessary to state that these identifications have always afforded an extremely powerful objection against the correctness of the position assumed by Emmons, because no species of trilobite is known to range from the Primordial Zone up to the top of the Lower Silurian. Hall's first volume was published in 1847 and as it is unquestionably the most important work on the Lower Silurian Fossils of North America it has been very generally accepted by our physical geologists as a guide. It is not surprising therefore that, in all the discussions that have taken place during the last fourteen years upon the age of these rocks, the majority of those who did not profess to be naturalists should have arranged themselves on the side of the leading Palæontologist of the country.

The formation was traced from New York through Vermont and there identified, by Prof. Adams the State Geologist, with the Hudson River group. The Canadian Surveyors continued it with great labor through a mountainous and partially uninhabited country for nearly five hundred miles further, from the northern extremity of Vermont to the neighborhood of Quebec and thence along the south side of the St. Lawrence to the mouth of that river at Cape Gaspé. In Canada the nomenclature of the New York Survey was adopted for all the formations and it appears from his several reports that Sir W. E. Logan could find nothing in the physical structure of the country to authorize him to make an exception in favor of this particular series of rocks. It has therefore always been called the Hudson River group in the publications of the Canadian Survey.

It will be seen by the following correspondence that the new light thrown upon the question of the age of these rocks by the fortunate discovery of a large number of fossils near Quebec, now leads him to place them at the base of the Lower Silurian, and as he states that the shales in Vermont in which the trilobites no-

ticed in Mr. Barrande's letter to Prof. Bronn have been found may be subordinate to the Potsdam it seems probable that the sequence contended for by Emmons will turn out to be at least for the greater part the true one.

II.

ON THE PRIMORDIAL FAUNA AND THE TACONIC SYSTEM OF EMMONS, IN A LETTER TO PROF. BRONN OF HEIDELBERG.*

"Paris, July 16, 1860.

"..... I have recently received, thanks to the kindness of Mr. E. Billings, the learned palæontologist of the Geological Survey of Canada, a very interesting pamphlet entitled 'Twelfth Annual Report of the Regents of the University of the State of New York, 1859.' If you possess this publication, you will find there, at page 59, a memoir of Prof. J. Hall, entitled 'Trilobites of the Shales of the Hudson River Group.' This savant there describes three species under the names *Olenus Thompsoni*, *Olenus Vermontana*, and *Peltura* (*Olenus*) *holopyga*. The well-defined characters of these trilobites are described with the clearness and precision to be expected from so skillful and experienced a palæontologist as James Hall.

"Although the specimens are incomplete, their primordial nature cannot admit of the least doubt, when the descriptions are read, accompanied with wood engravings which the large dimensions of these three species render sufficiently exact. The first is 105 millim. long by 80 broad, the other two are somewhat smaller.

"The heads of the two *Oleni* being deteriorated, the furrows of the glabella cannot be recognized. The thorax has a common and remarkable character, which consists in the greater development of the third segment, the point of which is stronger and longer than in all the other pleura. This is a striking resemblance to the *Paradoxides*, the second segment of which has the same peculiarity. Besides, there is an intimate relation between these two primordial types, and we should not be surprised if America furnished us with forms uniting most of their characteristics. The pygidium of *O. Thompsoni*, the only one that is known, shows no segmentation, and attests by its exiguity its relation to a primordial trilobite. *P. holopyga*, by its whole appearance, resembles the species of Sweden so well known by the name of *P. Scarabæoides*.

"Thus all the characters of these three trilobites, as they are recognized and described by J. Hall, are those of the trilobites of the primordial fauna of Europe. This is so true, that I think I may say without fear, if M. Angelin, or any other palæontologist practised in distinguishing the trilobites of Scandinavia, had met with these three American forms in Sweden or Norway, he would not have hesitated to class them among the species of the Primordial fauna, and to place the schists enclosing them in one of the formations containing this fauna. Such is my profound conviction, and I think any one who has made a serious study of the trilobitic forms and of their vertical distribution in the oldest formations will be of the same opinion.

* Proceed. Boston S. N. Hist., vol. vii, Dec., 1860, p. 371.

"Besides, all who have seriously studied palæontology know well that each geological epoch, or each fauna, has its proper and characteristic forms, which once extinct reappear no more. This is one of the great and beautiful results of your immense researches, which have generalized this law, recognized by each one of us within the limits of the strata he describes.

"The great American palæontologist arrived long since at the same conclusion, for in 1847 he wrote the following passage in the *Introduction* to the first volume of the Monumental Work consecrated to the Palæontology of New York.

"'Every step in this research tends to convince us that the succession of strata, when clearly shown, furnishes conclusive proofs of the existence of a regular sequence among the earlier organisms. We are more and more able, as we advance, to observe that the Author of nature, though always working upon the same plan and producing an infinite variety of forms almost incomprehensible to us, has never repeated the same forms in successive creations. The various organisms called into existence have performed their parts in the economy of creation, have lived their period and perished. This we find to be as true among the simple and less conspicuous forms of the palæozoic series, as in the more remarkable fauna of later periods.'—*J. Hall*, '*Pal. of New York*,' i, p. xxiii."

"When an eminent man expresses such ideas so eloquently, it is because they rise from his deepest convictions. It must then be conceived that J. Hall, restrained by the artificial combinations of stratigraphy previously adopted by him, has done violence to his palæontological doctrines, when, seeing before him the most characteristic forms of the *Primordial fauna*, and giving them names the most significant of this first creation, he thinks it his duty to teach us that these three trilobites belong to a horizon *superior* to that on which the second fauna is extinguished.

"In effect, according to the text of J. Hall, the three trilobites in question were found near the town of Georgia, Vermont, in schists which are superior to the *true Hudson River group*. In his works J. Hall does not go beyond indicating the horizon of certain fossils, and no one would think of asking a guaranty for such indications. But on this occasion the great American palæontologist thinks it necessary to support his stratigraphical determination by another authority, chosen from the most respectable names in geology. The following is the note which terminates his Memoir.

"'Note.—In addition to the evidence heretofore possessed regarding the position of the shales containing the Trilobites, I have the testimony of Sir W. E. Logan, that the shales of this locality are in the upper part of the Hudson River group, or forming a part of a series of strata which he is inclined to rank as a distinct group, above the Hudson River proper. It would be quite superfluous for me to add one word in support of the opinion of the most able stratigraphical geologist of the American continent.'

"Now, when a savant like J. Hall thinks himself obliged to invoke testimony to guarantee the exactness of the position of a few fossils, it is clear that the determination of this position is difficult.

"In order to understand these difficulties I have consulted the maps and documents relating to the State of Vermont and the country in which the town of Georgia is situated, and, although the library of our Geological Society does not contain all that one could wish on this subject, I recognized easily that Georgia is placed in the region where the order of succession of the deposits is the most obscured by foldings and dislocations; so that the position of the schists in question could not have been determined by the incontestable evidence of direct superposition. Besides, the physical appearance of these schists is not that of the rocks constituting the typical group of Hudson River. This is verified by the Note of J. Hall, for it tells us that Sir W. E. Logan is inclined to make a distinct group of these schists *superior* to that of the Hudson, and which consequently *would crown the whole Lower Silurian division* of the continent.

"For the above reasons, the geological horizon on which the three *Oleni* of Georgia were found appears to me, at first view, to have been but doubtfully determined, and in complete opposition to palæontological documents.

"I do not think, then, that I weaken in the least degree the respect and confidence justly inspired by the labors of the American savants whose names have just been mentioned, when I ask them in the name of science to make new researches and new studies, that may lead to a final and certain solution of this important question.

"Doubtless, thanks to the progress of our knowledge, we are now no longer bound by the ancient conception of the simultaneous extinction and the total renovation of the faunæ. As for myself, in particular, it would not be possible to accuse me of similar views at the moment when I am publishing the explanation of my doctrine of colonies. But you will perceive that the facts which I invoke in support of this doctrine are far from sustaining the reappearance of a fauna after the extinction of the following fauna, which the three trilobites of Georgia would do, if they had really lived after the deposit of the Hudson River group.

"This reappearance would be still more astonishing, as among the three great Silurian faunæ the second fauna occupies the greatest vertical space and is probably the one which enjoyed the longest existence. Thus, to verify such a reappearance, the most incontestable proofs are required, for such a decision would compel the entire re-formation of one of our most important scientific creeds. "Yours very truly,

J. BARRANDE."

In another letter, dated Paris, 14th August, 1860, Mr. Barrande says:—

"You will easily perceive the interest and importance of the question, even if it were only raised on account of the three *Oleni* of Georgia; but it takes in now a much wider field, owing to a letter I have just received from Mr. Billings, official Palæontologist of the Geological Survey of Canada, who informs me that he has found lately, in the schists and limestones near Quebec, considered as being the prolongation of those in question in Vermont, nearly one hundred species, almost all new. Twenty-six of these come from a white limestone, and seem to him to be the true representatives of the Primordial fauna, and he cites among them *Conocephalites*,

Arionellus, *Dikellocephalus*, etc., that is, very characteristic forms of this fauna.

"In another limestone, which is gray, he finds thirty-nine species, all different from the first, and representing, on the contrary, the most distinct types of the second fauna. Finally, the black schists furnish him with *Graptolites*, *Lingulæ*, etc., etc., fossils which at first sight cannot determine a horizon, because they are found upon several Silurian horizons.

"While waiting for these very obscure stratigraphical relations to be disentangled, and without committing in any manner Mr. Billings, who should preserve the independence of his opinion, I may yet express to you my view wholly personal, and of which at this moment I take the entire responsibility. I think, then, that this region of schists and limestones of Vermont, in other words the *Taconic system*, will reproduce in America what took place in England as to the Malvern Hills, and in Spain for the Cantabrian chain,—that is to say, the Primordial fauna, after having been disregarded, will regain its rights and its place, usurped for a time by the second fauna.

"You see it is a great and noble question, whose final solution will complete the imposing harmonies existing already between the series of palæozoic faunæ of America and that of the contemporaneous faunæ of Europe, leaving to each the imprint peculiar to its continent.

"I can well imagine, from the position previously taken by our learned American brethren on the subject of the Taconic system, that the final solution of which I speak will not be obtained without debate, and perhaps some wounding of self-love, for some opinions that appear to be dominant must be abandoned.

"But experience has taught me that in such cases the most elevated minds turn always first to the light, and put themselves at the head of the movement of reform. Thus, when in 1850 I recognized the Primordial fauna in the Malvern Hills, where the second fauna only had been found, Sir Henry de la Beche and Sir Roderick Murchison were the first to adopt my views, to which little by little the other official geologists agreed; Edward Forbes ranged himself publicly on my side in 1853 in 'The Geological Survey,' while others still hesitated, until now there is no longer any opponent.

"I think there will be the same experience in America, and that in a few years from this time the opinions of your savans will have undergone a great change as regards this question.

"It is a fine opportunity for Dr. Emmons to reproduce his former observations and ideas with more success than in 1844.

"Yours very truly,

J. BARRANDE."

III.

REMARKS ON THE FAUNA OF THE QUEBEC GROUP OF ROCKS AND THE PRIMORDIAL ZONE OF CANADA.* (IN A LETTER ADDRESSED TO MR. JOACHIM BARRANDE OF PARIS, BY SIR WILLIAM E. LOGAN, DIRECTOR OF THE GEOL. SURVEY OF CANADA.)

Montreal, 31st Dec., 1861.

My Dear Mr. BARRANDE:

I am much indebted to you for your letter of the 6th of August, which was accompanied by a copy of your communication to Professor Bronn of Heidelberg, dated 16th July. Agreeably to your request, I took an early opportunity of letting Mr. Hall have a copy of your communication to Prof. Bronn, and he received it on the 11th or 12th September, 1860.

I am of course aware, from the correspondence you have had with my friend Mr. Billings and myself, how far you are acquainted with our discoveries at Quebec. On two occasions, just previous to the receipt of your last letter to Mr. Billings (received the 8th November), I devoted the short time I could spare from other engagements connected with the Geological Survey, to farther researches at Point Levi. I have satisfied myself, notwithstanding the conglomerate aspect of the bands of rock which contain our new fossils, that the fossils are of the age of the strata. Without entering at present on minute details of structure, I may say that the chief part of the specimens, found up to this time, are from two parallel out-crops, which might be taken as representing two distinct layers. If they are such, they are comprehended in a thickness of about 150 feet; but the circumstances of the case, connected with the physical structure, make it probable that the one band is a repetition of the other through the influence of an anticlinal fold or a dislocation. Both out-crops dip to the southeastward.

From the more northern out-crop (which we shall call A^2) we have obtained *Orthis* 1, *Leptæna* 1, *Camerella* 1, *Lingula* 2, *Discina* 1, *Agnostus* 3, *Conocephalites* 1, *Arionellus* 4, *Dikellocephalus* 6, *Bathyurus* 4. From the more southern out-crop (which we shall call A^3) we have *Dictyonema* 1, *Orthis* 2, *Leptæna* 1, *Strophomena* 1, *Camerella* 1, *Cyrtodonta* (?) 1, *Murchisonia* 3, *Pleurotomaria* 7, *Helicotoma* 2, *Straparollus* 2, *Capulus* 2, *Agnostus* 1, *Bathyurus* 4, *Cheirurus* 2, *Amphion* 2. From a third out-crop, which is still farther southward, and supposed to be another repetition of the same band (which we shall call A^4), we have *Orthis* 1, *Camerella* 1, *Asaphus* (*A Illænoides*) 1, *Bathyurus* 1. Tracing A^2 or A^3 round the extremity of a synclinal, and finding occasional indications of the fossils of A^2 and A^3, we arrive at a position on the south side of the synclinal. We shall call the position P. Here the band A^2 or A^3 ends, but a bed of

* Communicated to this Journal by Sir William Logan.

sandstone a little above it is traceable over an anticlinal to a junction with a conglomerate band lower than A^2 or A^3, showing that A^2 or A^3 must merge into it. Call this A^1. In this we have *Asaphus* (*A. Illœnoides*) 1, *Menocephalus* (*M. globosus*) 1. These two species occur in the same fragment of rock. Of all these fossils, 1 *Orthis* is common to A^2, A^3 and A^4; 1 *Leptæna*, 1 *Camerella*, 1 *Lingula*, 1 *Agnostus*, and 1 *Bathyurus*, are common to A^2 and A^3; 1 *Asaphus* is common to A^3 and A^1.

The dip at P is to the southeastward, and therefore an inverted dip. Northwest of this, and therefore above it, at such a distance as would give a thickness of between 200 or 300 feet, we have a band of shale with nodules of limestone, the nodules made up of other rounded masses in a matrix holding fossils, many of them silicified. From a few of these compound nodules we have obtained *Orthis* 11, *Leptæna* 1; this band we shall call B^1. A band like this occurs about half a mile or more to the southwestward. It may be a higher band, or it may be the same band, but we shall call it B^2. From this we obtain *Crinoidæa* (columns) 3, *Orthis* 1, *Camerella* 1, *Nautilus* 1, *Orthoceras* 1, *Leperditia* 1, *Trilobites* (2 genera undetermined) 2. In another position to the southeast, on the southeast of the same anticlinal previously mentioned, we meet with a conglomerate band supposed to be the same as B^2; but, in case it should be different, we shall call it B^3. Here we have *Orthis* 3, *Pleurotomaria* 2, *Murchisonia* 1, *Ophileta* 1, *Helicotoma* 1, *Nautilus* 1, *Maclurea* 1, *Orthoceras* 3 or 4, *Cyrtoceras* 1, *Bathyurus* 1, *Illœnus* 2, *Asaphus* 1. Of all these fossils, 1 *Orthis* and 1 *Camerella* are common to B^1 and B^2; the same *Orthis* and *Camerella* with 1 *Leptæna* are common to B^1, A^4, A^3 and A^2.

To the north of all these exposures, and on the northwest side of a synclinal running parallel with the synclinal already mentioned, fossils have been obtained in a cliff of about 100 feet, composed of limestone conglomerate, thin bedded limestones and shales. Their equivalence is not yet quite certain, but the strata are supposed to be not far removed from A^1 and A^2. We shall call this cliff A. The fossils from it are *Tetradium* 1, *Orthis* 1, *Lingula* 2, *Trilobites* (genus undescribed) 1, with a great collection of compound *Graptolidæ*, described and being described by Mr. Hall under the genera *Graptolithus* 25, *Retiolites* 1, *Reteograptus* 2, *Phyllograptus* 5, *Dendrograptus* 3, *Thamnograptus* 3, *Dictyonema* 3.

I have given you these details of localities, because as the subject requires further investigation we do not yet wish to commit ourselves entirely as to the equivalency of separate exposures. But there is no doubt that the whole is one group of strata deposited under one set of alternating circumstances. The whole fauna, as known up to the present time, is composed of—

Articulata,	36	species.
Mollusca,	55	"
Graptolidæ,	42	"
Radiata,	4	"
	137	

Of this fauna not one species is found in the Anticosti group, where we have a gradual passage from the fauna of the Hudson River formation to that of the Clinton, and not one of any formation higher than the Chazy. Mr. Billings recognizes one species, *Maclurea Atlantica* (Billings) as belonging to the Chazy, and six species as belonging to the Calciferous. They are *Lingula Mantelli* (Billings), *Camerella* undescribed, *Ecculiomphalus* undescribed, *Helicotoma uniangulata* (Hall), *H. perstriata* (Billings), and one remarkable species of an undetermined genus, like a very convex *Cyrtodonta*, which occurs both at Mingan and point Levi. All of the forms, particularly the trilobites, remind the observer of those figured by Dr. D. Dale Owen from the oldest fossiliferous rocks of the Mississippi valley, while independent of the six species identical with Chazy and Calciferous forms, there are many others closely allied to those found in the latter formation in Canada.

From the physical structure alone no person would suspect the break that must exist in the neighborhood of Quebec, and without the evidence of the fossils, every one would be authorized to deny it. If there had been only one or two species of an ancient type, your own doctrine of colonies might have explained the matter, but this I presume would scarcely be applicable to so many identities in a fauna of such an aspect. Since there must be a break, it will not be very difficult to point out its course and its character. The whole Quebec group, from the base of the magnesian conglomerates and their accompanying magnesian shales to the summit of the Sillery sandstones, must have a thickness of perhaps some 5000 or 7000 feet. It appears to be a great development of strata about the horizon of the Chazy and Calciferous, and it is brought to the surface by an overturn anticlinal fold with a crack and a great dislocation running along the summit, by which the Quebec group is bronght to overlap the Hudson River formation. Sometimes it may overlie the overturned Utica formation, and in Vermont points of the overturned Trenton appear occasionally to emerge from beneath the overlap.

A series of such dislocations traverses eastern North America from Alabama to Canada. They have been described by Messrs. Rogers, and by Mr. Safford. The one in question comes upon the boundary of the Province not over a couple of miles from Lake Champlain. From this it proceeds in a gently curving line to Quebec, keeping just north of the fortress; thence it

coasts the north side of the Island of Orleans, leaving a narrow margin on the island for the Hudson River or Utica formation. From near the east end of the island it keeps under the waters of the St. Lawrence to within eighty miles of the extremity of Gaspé. Here again it leaves a strip of the Hudson River or Utica formation on the coast.

To the southeast of this line the Quebec group is arranged in long narrow parallel synclinal forms with many overturn dips. These synclinal forms are separated from one another on the main anticlinals by dark grey and even black shales and limestones. These have heretofore been taken by me for shales and limestones of the Hudson River formation, which they strongly resemble, but as they separate the synclinals of the Quebec group must now be considered older. I am not prepared to say that the Potsdam deposit in its typical form of a sandstone is anywhere largely developed above these shales, where the shales are in greatest force. Neither am I prepared to assert its absence, as there are in some places masses of granular quartzite, not far removed from the magnesian rocks of the Quebec group, which require farther investigation; but, from finding wind-mark and ripple-mark on closely succeeding layers of the Potsdam sandstone where it rests immediately upon the Laurentian series, we know that this arenaceous portion of the formation must have been deposited immediately contiguous to the coast of the ancient Silurian sea, where part of it was even exposed at the ebb of tide. Out in deep water the deposit may have been a black partially calcareous mud, such as would give the shales and limestones which come from beneath the Quebec group.

In Canada no fossils have yet been found in these shales, but the shales resemble those in which *Oleni* have been found in Georgia (Vermont). These shales appear to be interposed between eastward dipping rocks equivalent to the magnesian strata of the Quebec group, and they may be brought up by an overlapping anticlinal or dislocation. We are thus led to believe that these shales and limestones, which may be subordinate to the Potsdam formation, will represent the true primordial zone in Canada.

Mr. Murray has this season ascertained that the lowest rock that is well characterized by its fossils in the neighborhood of Sault Ste. Marie, near Lake Superior, really belongs to the Birdseye and Black River group, and that it rests on the sandstones of Ste. Marie and Lacloche, the fossiliferous beds at the latter place being tinged with the red color of the sandstone immediately below them. These underlying Lake Superior rocks may thus be Chazy, Calciferous, and Potsdam, and may be equivalent to the Quebec group and the black colored shales beneath. The Lake Superior group is the upper copper-bearing

series of that region, and rests unconformably upon the lower copper-bearing series, which is the Huronian system. The upper copper-bearing series holds nearly all the metals, including gold, and so does the Quebec group, each making an important metalliferous region. Each when unmetamorphosed holds a vast collection of red colored strata. The want of fossils in the Lake Superior group makes it difficult to draw lines of division, but if any part represents the primordial zone, I should hazard the conjecture that it is the dark colored slates of Kamanistiquia, which underlie all the red rocks.

Professor Emmons has long maintained, on evidence that has been much disputed, that rocks in Vermont, which in June, 1859 I for the first time saw and recognized as equivalent to the magnesian part of the Quebec group, are older than the Birdseye formation; the fossils which have this year been obtained at Quebec pretty clearly demonstrate that in this he is right. It is at the same time satisfactory to find that the view which Mr. Billings expressed to you in his letter of the 12th July, to the effect that the Quebec trilobites appeared to him to be about the base of the second fauna, should so well accord with your opinions; and that what we were last spring disposed to regard at Georgia as a colony in the second fauna, should so soon be proved, by the discoveries at Quebec, to be a constituent part of the primordial zone. I am, my dear Mr. Barrande,

Very truly yours,

W. E. LOGAN.

Mr. Joachim Barrande, Rue Mezière No. 6, Paris.

IV.

LETTER FROM JAMES HALL, PALÆONTOLOGIST OF NEW YORK, TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

Gentlemen,—In the Twelfth Annual Report of the Regents of the University* upon the State Cabinet of Natural History, I published descriptions of three species of Trilobites from the shales of the town of Georgia in Vermont, referring them to the age of the Hudson River group. These trilobites had been in my possession for some two years or more; and knowing the great interest that would attach to them, whenever published, I had waited, hoping that some new facts might be brought out touching the stratigraphical relations of these rocks in the town of Georgia.

After the descriptions had been printed and a few copies distributed, I learned that Sir William Logan was at that time

* The same to which Mr. Barrande refers in his text to Prof. Bronn, p. 312. The preceding communications sufficiently explain the subject under discussion.

actually investigating the rocks of that part of Vermont. Desiring to know the results of his latest researches in regard to the stratigraphical relations of these rocks, I withheld the final publication till the Meeting of the American Association for the Advancement of Science, in Springfield, and there showed to Sir William my descriptions as they now stand in the Report, and I then received his authority for the addition of the note which was appended.

This in a few words is a simple history of the matter relating to the publication of these species. I made no remarks or comparisons with the primordial fauna of Barrande in Bohemia, knowing that these features would be at once recognized by every palæontologist; while their reference to the genus Olenus showed my appreciation of the nature of the fossils.

I received a copy of the communication of Mr. Barrande, from Sir William Logan in September, a few days before setting out for my field duties in Wisconsin. Since my return to Albany, constant and pressing occupation has left me no time to consider a reply to a question of so much importance.

Later discoveries in the limestones associated with the shales at Quebec leave no longer a doubt, if any could have been entertained before, that the shales of Georgia, Vermont, are in the same relative position; and we must regard these three trilobites as belonging to the same fauna with the species enumerated by Sir William Logan as occurring in the Quebec group. Left to palæontological evidence alone, there could never have been a question of the relations of these trilobites, which would at once have been referred to the primordial types of Barrande.

Sir William Logan yields to the palæontological evidence, and says, "*there must be a break.*" He gives up the evidence of structural sequence which he had before investigated and considered conclusive; and having heretofore relied upon the opinion of the distinguished Geologist of Canada in regard to a region of country to which my own examinations had not extended, I have nothing left me but to go back to the position sustained by palæontological evidence. Let us for a moment examine this palæontological evidence.

The identifications of the fossils of the Quebec group, certainly show a remarkable agreement between the trilobites of this group and those of the Potsdam sandstone, in the occurrence of *six species* of *Dikellocephalus* and one of *Menocephalus;* while the occurrence of many others is in agreement or not incompatible with the fauna of the Potsdam and Calciferous sandstones. The comparative values of the Trilobitic faunæ of this group and of the primordial zone of Europe, as established by Barrande, is better shown in a tabular form which I here append.

The Crustacean fauna of the primordial zone of Europe.

Paradoxides, Olenus, Peltura, Conocephalus, Ellipsocephalus,* Hydrocephalus, Sao, Arionellus,	These genera are all limited to the *fauna primordiale*, and none of the other European genera of trilobites are known in this fauna.
Agnostus,	Of the first and second fauna.
Amphion,	Placed with doubt in the first fauna, and is well developed in the second fauna.

The Crustacean fauna of the Quebec Group.

Conocephalus, Arionellus,	Genera of the *primordial zone.*
Agnostus,	A genus passing from the first to the second fauna.
Dikellocephalus, Menocephalus,	Genera of the Potsdam period.
Bathyurus,	Quebec group.
Asaphus,	Of the second fauna.
Illænus,	Of the second and third fauna.
Amphion,	Of the second fauna; and doubtfully of the first fauna in Sweden.
Ceraurus = Chierurus,	Of the second and third Silurian faunæ, and of the Devonian fauna.

We have therefore in the Quebec Group, two established genera of the primordial zone; one, Agnostus, which passes from the primordial to the second fauna; one, Amphion, cited as doubtful in the first fauna in Sweden, and known to be in the second; and three,—Asaphus, Illænus and Chierurus, which begin their existence in the second fauna. Of these, Asaphus begins and ends in the second; Illænus begins with the second and continues to the third; while Ceraurus = Chierurus begins in the second, extends through the third Silurian, and appears in the Devonian fauna.

Bathyurus is a new genus, and as yet has no stratigraphical value in comparisons. Those which I described as Olenus have proved to be not true Oleni; and though much resembling that genus, are nevertheless distinct; and I have proposed the names *Barrandia* and *Bathynotus* for the two forms.† These have yet no stratigraphical value, except so far as their relations to established genera may aid in that direction.

The genera *Dikellocephalus* and *Menocephalus* are of the Potsdam group; and so far the Quebec group is in parallelism with the Potsdam and Calciferous strata.

Of the other genera, we know Asaphus, Illænus and Ceraurus (= Chierurus) in the Trenton limestone and Hudson River groups; Illænus and Ceraurus in the Upper Silurian strata of Niagara age, or the third fauna of Barrande; while Ceraurus

* Not Elliptocephalus of Emmons.

† Thirteenth Annual Report of the Regents of the University of N. Y., on the State Cabinet of Natural History, Albany, December, 1860.

occurs also in the Devonian of Europe. Amphion is known in the second fauna in Europe, and, doubtfully in the first.

Ceraurus does not occur in this country, so far as I know, above the Niagara group; though known in the Devonian rocks of Europe.

The following tabular arrangement of the genera found in the Quebec group will serve to express more distinctly the relations of the Crustacean fauna of these rocks.

The letters at the head of the columns have the same references as those used in the communication of Sir William Logan.

	A	A^1	A^2	A^3	A^4	B^1	B^2	B^3
Arionellus,	....	—	4	....	....	....	....	....
Conocephalus,	....	—	1	....	....	....	....	....
Agnostus,	....	—	3	1	....	....	....	...
Dikellocephalus,	....	—	6	....	....	....	....	....
Menocephalus,	—	1	—	—	—	....	....	....
Bathyurus,	....	—	4	4	1	....	....	1
Barrandia, } *Shales of*	....	....	....	....	....	....	....	....
Bathynotus, } *Georgia, Vt.*	....	....	....	....	....	....	....	....
Amphion,	....	....	....	2	....	....	....	....
Asaphus,	....	1	....	....	1	....	....	1
Illænus,	....	....	....	....	....	....	....	2
Chierurus (Ceraurus),	....	....	....	2	....	....	....	....
Leperditia,	....	....	....	....	....	....	1	....
Lingula,	2	—	2	....	....	....	....	....
Discina,	....	—	1	....	....	....	....	....
Orthis,	1	—	1	2	1	11	1	3
Leptæna,	....	—	1	1	....	1	....	....
Strophodonta,	....	—	....	1	....	....	....	....
Camarella,	....	....	1	1	1	....	1	....
Cyrtodonta?	....	....	....	1	....	....	....	....
Maclurea,	....	....	....	....	....	....	....	1
Murchisonia,	....	....	....	3	....	....	....	1
Pleurotomaria,	....	....	....	7	....	....	....	2
Helicotoma,	....	....	....	2	....	....	....	1
Straporollus,	....	....	....	2	....	....	....	....
Capulus,	....	....	....	2	....	....	....	....
Ophileta,	....	....	....	....	....	....	....	1
Nautilus,	....	....	....	....	....	....	1	1
Orthoceras,	....	....	....	....	....	....	1	3 or 4
Cyrtoceras,	....	....	....	....	....	....	....	1
Crinoidal columns,	....	....	....	....	....	....	3	....
Tetradium,	1	....	....	....	....	....	....	....
Dictyonema,	3	....	....	1	....	....	....	....
Graptolithus,	25	....	....	....	....	....	....	....
Retiolites,	1	....	....	....	....	....	....	....
Reteograptus,	2	....	....	....	....	....	....	....
Phyllograptus,	5	....	....	....	....	....	....	....
Dendrograptus,	3	....	....	....	....	....	....	....
Thamnograptus,	3 [?]	....	....	....	....	....	....	....

In this table we find, of previously recognized trilobites of the primordial fauna, two genera and five species; of previously known genera of the second and third faunæ, *four genera* and eight species; *two genera* before known in the Potsdam sandstone and seven species; and of Agnostus, which is of the first and second faunæ, two species; and one new genus with nine species.

These are certainly very curious results; and a modification of our views is still required to allow four genera and eight species, (or leaving out Amphion) three genera and six species of the Trilobites of the second fauna to be associated with two genera and five species of Trilobites of the primordial fauna, and yet regard the rocks as of primordial origin.

The Brachiopodous genera, Lingula, Discina, Orthis, Leptæna and Strophomena, have a great vertical range, and are known in the Lower and Upper Silurian, and most of them in the Devonian; while Camerella so far as known is a Lower Silurian form of the second fauna (perhaps also in a lower position).

Of the Gasteropoda, Maclurea and Ophileta are restricted to Lower Silurian rocks, but occur mainly in the second fauna. The other genera occur likewise in the second fauna and in the Upper Silurian rocks as well as some of them in Devonian. The same is true of the Cephalopoda enumerated.

Tetradium is known in the second fauna of the Lower Silurian rocks, and in the upper part of the Hudson River group at the west. Dictyonema is a genus known from Lower Silurian to Devonian strata.

Graptolithus proper extends to the Clinton group of New York; and the same is true of Reteograptus. Thamnograptus occurs in the rocks of the Hudson River group near Albany, and in the Quebec rocks. Phyllograptus and Retiolites are known in the Quebec rocks only; while the typical form of Dendrograptus occurs in the Potsdam sandstone, and, likewise, in three other species, in the Quebec rocks.

We find, therefore, in the other genera except trilobites, very little satisfactory evidence, on which to rely in the present state of our knowledge, for determining the position of these strata.

In the present discussion, it appears to me necessary to go further, and to inquire in what manner we have obtained our present ideas of a primordial, or of any successive faunæ. I hold that in the study of the fossils themselves there were no means of such determination prior to the knowledge of the stratigraphical relations of the rocks in which the remains are inclosed. There can be no scientific or systematic palæontology without a stratigraphical basis. Wisely then, and independently of theories, or of observations and conclusions elsewhere, geologists in this country had gone on with their investigations of structural geology. The grand system of the Professors W. B. and H. D. Rogers had been wrought out not only for Pennsylvania and

Virginia but for the whole Appalachian chain; and the results were shown in numerous carefully worked sections. In 1843, '44 and '45 I had myself several times crossed from the Hudson River to the Green Mountains, and found little of importance to conflict with the views expressed by the professors Rogers in regard to the chain farther south, except in reference to the sandstone of Burlington, and one or two other points, which I then regarded as of minor importance.

Sir William Logan had been working in the investigations of the geology of Canada; and better work in physical geology has never been done in any country.

This then was the condition of American geology, and investigators concurred, with little exception, in the sequence based on physical investigations. As I have before said, our earliest determinations of the successive faunæ depend upon the previous stratigraphical determinations. This I think is acknowledged by Mr. Barrande himself, when he presents to us, as a preliminary work, a section across the centre of Bohemia. With all willingness to accept Mr. Barrande's determination, fortified and sustained as it is by the exhibition of his magnificent work upon the trilobites of these strata, we had not yet the means of parallelizing our own formations with those of Bohemia by the fauna there known. The nearest approach to the type of primordial trilobites was found in those of the Potsdam sandstone of the northwest, described by Dr. D. D. Owen; but none of these had been generically identified with Bohemian forms;* and the prevailing opinion, sanctioned as I have understood by Mr. Barrande, was that the primordial fauna had not been discovered in this country, until the re-discovery of the Paradoxides Harlani, at Braintree, Mass. The fragmentary fossils published in vol. 1, Palæontology of New York, and similar forms of the so-called Taconic System, were justly regarded as insufficient to warrant any conclusions. It then became a question for palæontologists to decide, whether determinations founded on a physical section in a disturbed and difficult region of comparatively small extent, were to be regarded as paramount to determinations founded on examinations, like those of the professors Rogers, extending over a distance in the line of strike of five or six hundred miles; and those of Sir William Logan over nearly as great an extent from Vermont to Gaspé.

It is not possible for me, at this moment, to give the time necessary for a full discussion of this important subject. In presenting these few facts in this form, I am far from doing it in the spirit of cavilling, or as an expression of distrust in any direction. It is plain that the case is not met in Mr. Barrande's plan of successive Trilobitic faunæ; and the facts yet brought out do

* The glabellæ of small trilobites undistinguishable from Conocephalus occur in the Potsdam sandstone near Trempaleau, Wisconsin, on the Mississippi river.

not serve to clear up the difficulty. It is evident that there is an important and perplexing question to be determined,—one that demands all the wisdom and sagacity of the most earnest inquirers, and one which calls for the application of all our knowledge in stratigraphical geology and in palæontology;—one in which coöperation, good will and forbearance are required from every one, to harmonize the conflicting facts as they are now presented. The occurrence of so many types of the second fauna in the rocks at Point Levi, associated with a smaller number of established primordial types, offers us the alternative of regarding these strata as of the second stage, with the reappearance of primordial types in that era, or of bringing into the primordial zone several genera heretofore regarded as beginning their existence in the second stage: in either case, so far as now appears, conflicting with the scheme of Mr. Barrande in reference to the successive faunæ of Trilobites as established in Bohemia and the rest of Europe.

For myself I can say, that no previously expressed opinion, nor any "*artificial combinations of stratigraphy previously adopted*" by me, shall prevent me from meeting the question fairly and frankly. I have not sought a controversy on this point, but it is quite time that we should all agree that there is something of high interest and importance to be determined in regard to the limitation of the successive faunæ of our older palæozoic rocks.

I am very truly yours, &c.,

JAMES HALL.

Albany, N. Y., January 23, 1861.

ART. XX.—*On a new Lead-Salt, corresponding to Cobalt Yellow;* by S. D. HAYES, of Boston.

IN the course of some investigations on the cobalto-cyanid compounds, I was obliged to use a quantity of cobalt yellow, the pigment discovered by M. Saint Evre in 1852.* All the methods described for preparing this salt are very tedious, so that it became an object to find a more ready means. The best method, which has heretofore been given, is to precipitate a solution of nitrate of cobalt, with an excess of potash; then by passing a current of deutoxyd of nitrogen (NO^2) through the mass, the cobalt yellow is obtained; but the greater part of the NO^2 passes through, without being absorbed; the experiment requires hours; and the amount of salt so obtained is very small.

As the composition of this body is considered doubtful, it occurred to me that it might be made from peroxyd of nitrogen (hyponitric acid, NO^4), and after a few trials, I obtained it by this

* Annal. Ch. Phys., 3d series, xxxviii, 177.

agent very readily, in large quantities, and found that all the cobalt contained in a solution may thus be converted into cobalt yellow. Two bottles, connected, and supplied with funnel tubes, are about half filled with a solution of nitrate of cobalt, to which potash, slightly in excess, is added. On passing through the solution a brisk current of NO^4, the mass in the first bottle soon changes color, and the pigment begins to fall; by adding small quantities of potash, occasionally, through the funnel tubes, all the cobalt may be removed. The NO^4 is most readily prepared, by allowing a current of NO^2 made from copper and diluted nitric acid, in a small flask, to mix with a current of common air from a gasometer, in a dry empty bottle, before passing into the cobalt solutions. The current of air can be regulated at the gasometer, and the flask for generating NO^2 can be easily removed, and replenished when necessary. A solution of the carbonate of potash may be used, instead of caustic potash, for precipitating the cobalt solutions, with the same result.

A. Stromeyer, when working upon this salt, endeavored to obtain an analogous body with lead; he succeeded in getting a yellow solution, by means of nitrite of potash, and acetic acid, in a solution of lead, but he then added cobalt, which gave a precipitate.*

On treating a solution of nitrate of lead with potash and passing through it a current of NO^4, precisely as in making the cobalt-yellow, I found that all the NO^4 was absorbed, and as the oxyd of lead disappeared, the solution became very yellow; on evaporating, and crystallizing this, I obtained large, yellow, prismatic crystals; nitrate of potash crystallizes at the same time, and if the NO^4 has been passed through the lead oxyd mixture too long, nitrate of lead is formed.

The yellow salt was easily separated and recrystallized. The bases were determined as sulphates, with the following results:

I. 0·7462 grms. pure salt gave 0·4200 grms. sulphate of lead, and 0·0097 grms. lead = 0·3195 grms. oxyd of lead, and 0·2472 grms. sulphate of potash = 0·1335 grms. potash.

II. 1·459 grms. gave 0·6387 grms. oxyd of lead, and 0·2593 grms. potash.

III. 1·0271 grms. gave 0·43745 grms. oxyd of lead, and 0·1881 grms. potash.

The nitrogen was determined as gas; metallic copper reduced from the *fine* oxyd, being used in the combustion tube with a little oxyd at the fore end; the gas was collected, and washed in a small apparatus, then transferred to the eudiometer, where it was measured.

I. 0·1926 grms. salt gave 45·6277 cubic centimeters, nitrogen, temperature 60° C.; pressure 277·5 millimetres = 16·30 c. c., at 0° C. and 760 mm. pressure = 0·2048 grms.

* Ann. Ch. und Pharm., xcvi, 228.

II. 0·1958 grms. gave 16·23 c. c. at 0° C. and 760 mm. pressure = ·0226 grms.

The water was determined by combustions with metallic copper.

I. 0·7834 grms. gave 0·0274 grms. water.
II. 0·9145 grms. gave 0·0314 grms. water.
III. 0·4735 grms. gave 0·0177 grms. water.

These results sum up as follows.

	I.	II.	III.	IV.
Oxyd of lead,	42·81	43·08	42·59	43·22
Potash,	17·90	17·77	18·31	"
Nitrogen,	10·63	"	10·35	"
Water,	3·49	3·43	3·73	"
Oxygen, by difference,	25·16	"	25·02	
	100·00		100·00	

The above analyses correspond to the following calculated formula:

PbO,	111·56	42·98
KO,	47·	18·10
N_2,	28·	10·78
O_5,	64·	24·67
HO,	9·	3·47
	259·56	100·00

As this salt crystallizes out with nitrate of potash, it is of about the same degree of solubility, in either hot or cold water, and the solution may be boiled for some time, without any decomposition: but it is readily decomposed by sulphuric, hydrochloric, or nitric acid, giving off red fumes. With the common reagents, it acts as nitrate of lead, but with a solution of sulphate of cobalt, it gives cobalt yellow, which goes down with the sulphate of lead. It loses its atom of water at 100° C., but if the temperature be raised a few degrees higher, the red fumes are given off abundantly. The crystals are of a bright yellow color, and remain unaltered in the air.

I am not yet prepared to give this salt any decided *rational* formula, but its composition may be expressed in several ways, as below. When $2NO_4$ are passed over 2KO, we get $KONO_5$ and $KONO_3$, two distinct salts, but if $2NO_4$ be passed over CoO and KO, as in the case of cobalt yellow, or over PbO and KO as in this salt, we get only one salt of a double composition which we must write—

$$KONO_3\,CoONO_5 \text{ or}$$
$$KONO_3 \text{ or } PbONO_5 + HO$$

But there are objections to this: cobalt yellow is almost or quite insoluble in water. These salts may also be looked upon as double per-oxyds, in which two equivalents of oxygen have been replaced by two equivalents of NO_4; but from the nature of the salts, I hardly think that NO_4 exists in them. How-

ever, Gmelin describes a salt to which he gives the formula $2PbO, NO_4$ Aq,* and we express the composition of these salts quite as well, by writing them thus,

$$KONO_4, CoONO_4 \text{ or}$$
$$KONO_4, \text{ or } PbONO_4+HO$$

This subject will be pursued, and I hope to get several other salts, which must give some reactions that will lead to the right rational formulæ.

Heidelberg, Baden, Dec. 5th, 1860.

ART. XXI.—*Sketch of the Geology of the Country about the Head-waters of the Missouri and Yellow Stone Rivers;* by Dr. F. V. HAYDEN, Geologist to Capt. Raynolds's Expedition, with an Introductory letter by Capt. W. F. Raynolds, U. S. Topographical Engr.

A. CAPT. RAYNOLDS'S LETTER.

[THE following rapid sketch of the main geological features of the country passed over by the recent expedition to the Head-waters of the Yellow Stone and Missouri rivers, prepared by Dr. F. V. Hayden the Geologist of the Expedition, is submitted for publication by authority of the Honorable Secretary of War.

The district that was examined by the expedition is bounded by the Missouri river on the north and east, by the Platte on the south and by the dividing crest of the Rocky Mountains on the west, and operations were strictly confined to those limits, excepting between the head of Wind river and the Madison fork of the Missouri where the nature of the country was such as to force my division of the party across the main chain of the mountains.

The expedition was in the field for two entire seasons (1859 and 1860) and during about half of the first and the whole of the last season, was divided into two sections or divisions, the first under my immediate control, the second under Lt. Maynadier, U. S. A., the routes travelled over being widely separated so that the amount of labor performed was equal to what would have required three and a half years for a single party; and as operations were all conducted in concert the results must in some respects be more valuable than if obtained by a single party in a longer time.

The total land travel of the different branches of the expedition amounted to nearly five thousand miles independent of having descended in skin and flat boats, the Missouri from Fort Benton to Omaha, N. T., and the Yellow Stone from near the mountains to its mouth.

With the exception of the rivers most of the country had never before been traversed by an exploring party, nor indeed by any whites excepting trappers and not by them for the past fifteen or twenty years.

During the winter months, while the party was stationary on the Platte, Dr. Hayden made a geological examination of the country to the southward along the base of the mountain chain to near Pike's Peak. Dur-

* Handbuch, Bd. 3, s. 142.

ing the active operations of the party he accompanied that part of the command that was with myself—the geological examinations made by the second division were under the immediate direction of Dr. C. M. Hines of this city.

It is believed that the final results of the expedition will add largely to all branches of the scientific knowledge of the country.

W. F. RAYNOLDS, Capt. Top. Engrs. Comdg.]

Washington, D. C., Jan. 17th, 1861.

B. Dr. Hayden's Sketch.

The observations made during the recent expedition to the head waters of the Missouri and Yellow Stone rivers, under the command of Capt. Wm. F. Raynolds, T. E., have served to extend quite largely our knowledge of the geographical area of the different geological formations already indicated as existing in the far West. I propose in the following paper to present a brief abstract of the leading facts ascertained with a view to their bearing upon the physical geology of the mountain chains. I know that it will be impossible within the limits of a single paper to make every point as clear as could be desired or to use terms in all cases in their usually restricted sense. Much of the country passed over, west of the Black Hills, had never before been explored by scientific men, no maps existed which exhibited its topography with any pretensions to accuracy, and the mountain ranges which were known to exist in that region from information given by traders and trappers were not always laid down in their true geographical localities or with their proper trend, and not until the forthcoming report of Capt. Raynolds, now in course of preparation, appears, can these deficiencies be supplied. Moreover, the wild and broken character of the surface of the country examined, uninhabited except by roving tribes of hostile Indians, precluded the possibility of perfect accuracy in all the minor details, and we can only hope that we have obtained a general idea of the principal geological features of the vast area explored. The rocks observed belong to the different geological periods in the following order:

I. Granite, Stratified Azoic, and Eruptive Rocks,*
II. Potsdam Sandstone, (Silurian,)
III. Carboniferous Rocks, (including Permian, ?)
IV. Red Arenaceous Deposits,
V. Jurassic Beds,
VI. Cretaceous with its divisions,
VII. Tertiary Deposits.

* By granite or granitoid, I mean those unstratified crystalline rocks in the West which hold a lower position than any of the stratified deposits and for the most part possess a uniform character, forming the central portions of the larger mountains; by stratified azoic, a series of non-fossiliferous stratified beds, apparently sedimentary between the granite and Potsdam sandstone, and by eruptive rocks, those which have been melted by volcanic heat and brought to the surface in a more or less fluid condition, at various periods.

I. Granite, Stratified Azoic, and Eruptive Rocks.

Under the first division of my subject I will take up the mountain elevations as they appeared in their detached portions along our route. It is now well known that the term "Rocky Mountains" is quite general in its application including a vast number of more or less important ranges of mountains, which when examined in detail seem to have been elevated with very little regularity and in many instances to be but slightly connected, but when viewed in the aggregate to present a trend nearly northwest and southeast. Before reaching the main range we find along the eastern slope many detached minor elevations showing the wide geographical area under which the elevating forces acted.

I allude in the first place to the Black Hills, the northern portion of which we examined on our route from Fort Pierre on the Missouri to the Yellow Stone river. These Hills form the most eastern outlier of the Rocky Mountains and would seem to be an independent elevation were it not for a low anticlinal which extends across the plain country southward connecting it with the Laramie Mountains. The central portion is composed of a coarse flesh colored feldspathic granite with a series of metamorphic slates and schists superimposed, and thence upon each side of the axis of elevation, the various fossiliferous formations of this region follow in their order, to the summits of the Cretaceous, the whole being more or less inclined against the granitic rocks. The distance across the granitoid nucleus, is from fifteen to thirty miles and on each side of the crest or axis of elevation we find the corresponding portions of the fossiliferous beds from the Silurian to the summit of the Cretaceous. The evidence therefore, is conclusive that all the unchanged sedimentary strata at a period of comparatively recent date extended continuously over the whole area occupied by the Black Hills. The eruptive rocks reveal themselves at various localities as at Bear Peak, Inyankara Peak, &c. Bear Peak is a protrusion of very compact igneous rocks, almost isolated from the main range of the Black Hills, and Inyankara Peak is for the part composed of pentagonal basaltic columns arranged in a vertical position. There is no evidence however that they were formed by any force independent of that which elevated the entire range of mountains.

The next range that we examined was the Big Horn which is perhaps the most important detached outlier on the eastern side of the main crest of the continent. This seems to trend nearly northwest and southeast, extending into the valley of the Yellow Stone. The nucleus of these mountains is also composed of red feldspathic granite, with a series of stratified azoic rocks; and the unchanged sedimentary strata to the summit of the Cretaceous and including a portion of the Lignite Tertiary can be

seen in regular sequence outward inclining at greater or less angles. From the observations of Dr. C. M. Hines, who acted as Geologist to the exploring division under Lieut. Maynadier, we know that the corresponding formations occur on the opposite side of the axis of elevation and as we remarked of the Black Hills, we may infer from this fact, that the unchanged sedimentary beds once extended continuously over the whole area occupied by the Big Horn mountains, in a nearly horizontal position sometime during the Tertiary period. As we pass along the northeastern base of the Big Horn mountains southwestward, the ridges of upheaval seem to be presented *en echelon*, the range gradually making a flexure around to the westward. Toward the head waters of Wind River this range as it attaches itself to the main chain of the mountains, changes its lithological characters, no true ancient igneous rocks being seen, but instead, lofty peaks composed of eruptive rocks, presenting every variety of structure from compact basalt to porous lava-like masses.

The Laramie mountains, by which we mean the whole range from the Red Buttes to the Arkansaw, were examined with some care from Red Buttes southward nearly to Pike's Peak. There is a remarkable similarity in the general geological features of all the mountains on the eastern slope. The more lofty elevations as Long's and Pike's Peaks with other ridges and peaks scarcely less lofty than those just mentioned, are composed of the same coarse feldspathic granite before alluded to, but the lower ridges are formed to a great extent of a ferruginous feldspathic granite which easily yields to atmospheric agencies, and the surface of the country is paved with crystals of feldspar in consequence of its decomposition. All along the base and often extending up to the crest of the mountains, we see the outcropping edges of the fossiliferous rocks inclining at greater or less angles, and on crossing over into the Laramie Plains we find the corresponding strata leaning from the opposite side. The granitoid nucleus varies from eight to twenty miles in width. No indications of true eruptive rocks were observed in this range. The Medicine Bow and Sweet Water mountains appear to be of the same character for the most part, but on the east side of the Sweet Water river the evidence of igneous action is shown on a large scale. The ancient volcanic material would seem to have been elevated to a great heighth in but a partially fluid condition and then to have gradually cooled, affecting to a greater or less extent the fossiliferous strata in contact.

Near the junction of the Popo Agie with Wind River, we came in full view of the Wind River mountains which form the dividing crest of the continent, the streams on the one side flowing into the Atlantic, and those on the other into the Pacific. This range is also composed to a large extent of red and gray feldspathic granite with the fossiliferous rocks inclining high

upon its sides. After passing the sources of Wind River, the mountains appear to be composed entirely of eruptive rocks. Even the three Tetons which raise their summits eleven thousand feet above the ocean level are formed of very compact basaltic rock. The Wasatch and Green River ranges, where we observed them have the same igneous origin and the mountains all along the sources of the different branches of the Columbia exhibit these rocks in their full force. In Pierre's Hole, Jackson's Hole and other valleys surrounded by upheaved ridges, these ancient volcanic rocks seems to have been poured out over the country and to have cooled in layers, giving to vast thicknesses of the rocks the appearance of stratified beds.

The mountains about the sources of the Missouri and Yellow Stone rivers are of eruptive origin and in the valley of the Madison fork of the Missouri are vertical walls of these ancient volcanic rocks one thousand to fifteen hundred feet in height, exhibiting the appearance of regularly stratified deposits dipping at a considerable angle. As we pass down the Madison we find some beds of feldspathic rocks and mica and clay slates beneath the eruptive layers, dipping at the same angle. After passing the divide below the three forks of the Missouri we see a number of partially detached ranges which appear to be of the same igneous character. In the Belt, Highwood mountains and indeed all along the eastern slope in this region we find continual evidence of the outpouring of the fluid material in the form of surface beds or in layers thrust between the fossiliferous strata. These igneous beds thin out rapidly as we recede from the point of effusion. A large number of these centres of protrusion may be seen along the slope of the mountains west of the Judith range. The erupted material sometimes presents a vertical wall three hundred feet high, then suddenly thins out and disappears. The Judith, Bear's Paw and Little Rocky Mountains seem to be composed for the most part of granite and other rocks, with igneous protrusions here and there. I have in a former paper expressed the opinion that the central portions of our mountain ranges are composed of feldspathic granite and to a certain extent this is true in regard to the more eastern outliers, but more recent observations have convinced me that these rocks which I have defined by the term eruptive compose by far the greater portion of the mountain masses of the west.

II. Potsdam Sandstone. (*Silurian.*)

The discovery of this formation in its western extension has already been announced in a former paper.* It was first made known as occurring in the Black Hills and resting upon the upturned or nearly vertical edges of the schists, clay slates and granitoid rocks, and the inference was drawn that the same rocks

* This Jour., [2], xxvi, 276.

would be found forming an outcropping belt all along the eastern slope of the Rocky Mountains. After leaving the Black Hills we next observed it along the margins of the Big Horn range near the summit, holding the same relative position and exhibiting the same lithological characters. A few thin layers of fine calcareous sandstone were observed filled with fossils characteristic of this period. At the head of LaBonte creek in the Laramie range I noticed a bed resting discordantly upon azoic slates, fifty to one hundred feet in thickness, holding the same position and possessing the same lithological characters which it reveals at other localities. I could discover no fossils in it at this point but I am confident that this bed represents the Potsdam sandstone. The same bed seems to occur all along the mountains from Laramie Peak to Cache la Poudre creek underlying the well-known Carboniferous strata and resting upon the decomposing granitoid rocks, which form the nucleus of the first ridge. This rock (the Potsdam) is more or less changed by heat from beneath, but I was able to trace it continuously from the source of the Chugwater creek to the source of Cache la Poudre, a distance of over one hundred miles. It was also seen along the eastern slope of the Wind River mountains but did not contain any organic remains.

The above facts show very clearly that in its western extension, the primordial zone of Barrande is represented only by a thin bed of sandstone never exceeding one hundred and fifty feet in thickness, and that is seen only in a very narrow outcropping belt near the margins of the mountain crests. The stratified azoic rocks upon which it rests discordantly so far as my observations have extended, never reach a very great thickness in the west.

III. Carboniferous Rocks, (Including Permian?).

On both sides of the divide of the Rocky Mountains, so far as our explorations have extended, a series of calcareous, areno-calcareous and arenaceous beds are seen which we have referred to the Carboniferous epoch. They vary in thickness at different points. Without specifying localities it will be sufficient to remark that all along the margins of any of the mountain elevations in the far West, these rocks are seen in a more or less inclined position.

Sometimes they are not visible for a short distance (as between the Laramie and Platte Rivers, twenty or thirty miles), but it is plain that they have either been removed by erosion, or concealed by more recent deposits. Along the Big Horn mountains there are alternate layers of sandstone, arenaceous and magnesian limestones, many of which show oblique laminæ and other indications that their deposition took place in shallow and perhaps turbulent waters. They are here developed to a thickness of one thousand

to fifteen hundred feet and incline high upon the sides of the mountains at an angle of 50° to 70°. They contain few fossils but these indicate rocks of the same age as those in the Black Hills. Along the Laramie mountains, from the Red Buttes to Pike's Peak, apparently the same limestones are seen inclining against the sides of the elevated ridges at greater or less angles and on the opposite side of the axis sloping down to the Laramie plains the corresponding strata are seen, though leaning at much smaller angles, usually from 9° to 15°. Along the Sweet Water and Wind River mountains these rocks are highly developed and incline against the sides of the ridges of elevation as heretofore described. The corresponding portions are also seen on the west slope of the main range at the sources of Green and Snake Rivers but not as conspicuously developed, the eruptive rocks predominating. Crossing back over the dividing crest near the sources of the Madison, Jefferson and Gallatin Forks of the Missouri, we find similar limestones largely developed and covering a considerable area on the eastern slope. Near the junction of the three forks and along Smith's or Kamas River we find them reaching a thickness of eight hundred to one thousand feet, often partially changed by contact with igneous rocks beneath. They were also observed around the Judith Mountains and also about the Bear's Paw and Little Rocky Mountains.

Nowhere in the Rocky Mountain range so far as my observations have extended, do the Carboniferous rocks seem to abound in organic remains and the few usually seen are generally found in a bad state of preservation and comprise a limited number of species. The precise period to which these rocks belong, which are so persistent in all disturbed regions, is not positively known, the evidence from organic remains pointing to the age of the Coal measures and sometimes to that of the Lower Carboniferous Period; probably both members of the system occur there.

At the foot of the Big Horn mountains near the head of Powder River, I observed at one locality a series of beds which indicated the presence of Permian rocks. These beds which are composed of cherty magnesian limestone are very much like those already described in northeastern Kansas and contain in great abundance some of the same species of fossils as *Myalina perattenuata* and others. I have also seen similar limestones in other localities but no fossils were detected and though having a Permian appearance they may belong to the upper portion of the Carboniferous.

The evidence is clear in many localities that prior to the deposition of the Red Marls succeeding the supposed Permian, a very great erosion of the surface of the Carboniferous rocks took place. We find, for example, in many localities only a thin representation of the Carboniferous rocks and again a full development, one thousand to fifteen hundred feet in thickness.

IV. Red Arenaceous Deposits.

Overlying the Carboniferous rocks and equally persistent with them is a series of red arenaceous Marl beds or gypsum-bearing marls which are coëxtensive with the upheaved sedimentary formations along the Rocky Mountains. The largest development of these beds which I have observed, occurs on the northeastern side of the Big Horn mountains and on the west slope of the Wind River mountains near the source of the Gros Ventres Fork of Snake River. From the Red Buttes on the North Platte to Pike's Peak these beds are often removed by erosion or concealed by superficial deposits, but their appearance in numerous places shows very clearly that beneath the surface they occupy a considerable area throughout the country bordering the mountain ranges, possibly extending entirely over the eastern slope. Passing over into the Laramie Plains we find that the red marls constitute the surface formation of the plain country. It has also been shown from Mr. H. Engelmann's explorations that these beds are revealed along the Wasatch Mountains, even south of Lake Utah, furnishing undoubted evidence that they belong to the same great deposit. The fact also that one thousand to fifteen hundred feet of red arenaceous beds are seen near the sources of Green River, leads to the inference that they continue southward far down the Green River valley to that portion which takes the name of Colorado, and are in fact a continuation of the extensive red deposits, described by various explorers in New Mexico.

These red beds are also seen under similar circumstances highly developed along the mountains at the sources of the Missouri. There seems to be a change in the lithological characters below the Gate of the mountains, the peculiar red deposits disappearing for the most part and a series of irregular layers of siliceous limestone with a reddish tinge, and with oblique laminæ, ripple mark and other indications of shallow water deposition. It is through these layers of rock that the Missouri River cuts its way from the foot of the mountains to the mouth of High Wood creek, about ten miles below the falls. They are also distinctly revealed around the Judith mountains. Along the Big Horn mountains thick layers of gypsum occur, but the gypsum beds are by no means co-extensive with the red deposits, and indeed are present in but few localities. Near the head of Powder River the aggregate thickness of the gypsum strata is about one hundred feet while near the source of Snake River there is a thickness from fifty to eighty feet. It also occurs to a considerable extent at the foot of the mountains, on La Bonte creek, a branch of the North Platte.

V. Jurassic Rocks.

These rocks are everywhere revealed, overlying the red deposits just mentioned and possessing an equal geographical extension. Their fullest development and most fossiliferous condition seems to be along the margins of the Black Hills where they have furnished the most satisfactory evidence of their age. Along the northeastern slope of the Big Horn mountains, this group of rocks presents its usual appearance of grey and whitish calcareous and arenaceous layers, with indurated somewhat variegated beds of more or less laminated marls, containing in great abundance *Belemnites densus, Pentacrinus asteriscus*, a new species of *Ostrea*, *Pecten*, &c.

At Red Buttes we find a fair development of these beds with the same fossils, but as we proceed southward toward Long's Peak, the intercalated laminated marls disappear and the whole formation seems to be reduced to a thickness of fifty to one hundred feet, with very few fossils. Along the southwest side of the Big Horn mountains and the northeast side of the Wind River mountains we have a thickness of Jurassic rocks from eight hundred to one thousand feet containing organic remains in the greatest abundance. Crossing the Wind River mountains we observed the strata corresponding to those upon the eastern side with *B. densus*, *Ostrea*, &c. Returning to the eastern slope at the sources of the Missouri we see occasional indications of their existence, but not so conspicuous as to be readily identified. The age of this group of rocks may be now considered as thoroughly established, so great a number of fossils which appear to be of undoubted Jurassic forms have been obtained.

I have remarked that the older fossiliferous beds doubtless pass beneath the more recent Cretaceous and Tertiary deposits and occupy a greater or less area underneath the prairie country east of the 'divide' of the Rocky Mountains. I have made this inference from the fact that where any elevations occur the complete series of fossiliferous beds are exposed around the axis of upheaval. That I may be not misunderstood by those geologists who have colored large areas Triassic and Jurassic on geological maps of the West, I would say, that I have never seen any of the older fossiliferous rocks from the Potsdam to the Jurassic inclusive, exposed except in narrow outcropping belts around the margins of the mountain elevations. The Carboniferous rocks occupy a belt from one to two miles wide, and the red arenaceous deposits are exposed over about the same area, while the Jurassic form a zone never more than one-fourth of a mile to three miles in width.

VI. Cretaceous Rocks with Subdivisions.*

The various subdivisions of the Cretaceous group in the West were observed at numerous localities. The strata in many places occupy large geographical areas, holding a horizontal position, in others forming a belt or zone of greater or less width around the mountain elevations. No. 1 is a well marked and distinct division along the Missouri River from Desoto to a point above the mouth of the Big Sioux River in the eastern portions of Kansas and Nebraska and in the south and southwest. But when we come into the vicinity of the mountain ranges in the northwest its typical form is wanting, and apparently an increased development of No. 2 only is seen. Along the Big Horn mountains, No. 2 is eight hundred to one thousand feet in thickness, composed of black, plastic clay with several layers of gray and yellowish calcareous sandstones ten to fifty feet in thickness. Along the Laramie and Wind River mountains the same characters are shown. After leaving the Missouri near the mouth of the Niobrara river No. 3 is never seen presenting its typical marly character. In the vicinity of the Black Hills we saw a series of beds composed of alternate thin layers of arenaceous and argillaceous sediments with *Ostrea congesta* and *Inoceramus problematicus* which may possibly represent No. 3. Along the Big Horn mountains and from Red Buttes to Cache la Poudre creek the same fossils were often found and some other indications of its existence, but no well marked typical beds were seen. It is now well-known that *O. congesta* and *I. problematicus*, range down into No. 2, so that No. 3 in the west and southwest may give place to an increased development of No. 2. Nos. 4 and 5 are largely developed every where, when not concealed by the overlying Tertiary deposits, especially along the Laramie mountains and in the valley of Cache la Poudre. In the Valley of Wind River all the Cretaceous rocks down to No. 2, appear to have been removed by erosion prior to the deposition of the Tertiary Beds, and the characteristic fossils of No. 2, are quite abundant. As we pass over mountains, we have inclining from the western slope, six to eight hundred feet of alternations of black plastic clays, arenaceous marls and beds of sandstones and limestone with a few seams of Carbonaceous matter passing up into calcareous and arenaceous compact rocks. In some arenaceous limestones near the middle of the series and extending upward, quite abundant fossils were observed, among them a large *Inoceramus*, two species of *Ostrea*, a large *Pinna*, four inches in length, a *Cardium* and a number of undetermined species with fragments of silicified wood. The general dip of these rocks is about 20°. These

* The Cretaceous rocks of the West have been divided into five formations, numbered 1, 2, 3, &c. A more careful study of No. 1 † may render it necessary to make other divisions.

well marked Cretaceous beds pass up quite imperceptibly into an enormous thickness of Lignite Tertiary. Passing over the dividing crest to the head waters of the Missouri, we did not observe any indications of Cretaceous rocks until we had descended below the three forks, where we find traces left after erosion. They do not reveal themselves conspicuously until we arrive within twenty or thirty miles of Fort Benton where the black plastic clay begins to overlap the Jurassic rocks with its characteristic fossils, and on reaching Fort Benton the plastic clay is quite homogeneous and is developed to a thickness of eight hundred feet. As we proceed toward the mouth of the Judith River and near the Judith mountains we find quite thick beds of concretionary sandstone which form the "Stone Walls," "Citadel," &c. It is from these beds that we have obtained a group of fossils which we have referred provisionally to No. 1, but which seem to be specifically distinct from all others in the West. It may be that when this group of beds now referred to Nos. 1 and 2, comprising a thickness of fifteen hundred to two thousand feet in this region are more carefully studied that several subdivisions will be made, having equal importance with the others. During the past season our route led us along the 'divide' between the Missouri and Yellow Stone rivers south of the Judith mountains, so that we passed outside of any good exposures of No. 1, as well as beyond the limits of the estuary beds at the mouth of the Judith. We must await a more thorough and detailed exploration of this region before we can state with entire confidence the succession of the beds.

VII. Tertiary Deposits.

In speaking of the Tertiary deposits of the Northwest, so far as known at the present time I propose to separate them into four divisions which will be sufficient for our immediate purposes. 1st, Estuary Deposits. 2nd, True Lignite Beds. 3rd, Wind River Valley Deposits. 4th, White River Tertiary Deposits.

The estuary deposits, of which the Judith basin may be regarded as the type, are quite remarkable and of a most interesting character. Opinions of a somewhat conflicting nature have been entertained in regard to them, owing to the peculiar character of the organic remains, but recent observations have convinced me that they are all of Tertiary age and that they are quite widely distributed throughout the far West. The lithological characters of the Judith deposit have already been sufficiently described and it has yielded many important fossils. A thin series of beds is also found near the sources of the Moreau, Grand and Cannon Ball rivers, and at the mouth of the Big Horn river we have a group of beds eight hundred to one thousand feet in thickness with fossils of the same character as those

occurring at the mouth of the Judith. The researches of Mr. H. Engelmann, in Utah, have also established the existence of an estuary deposit in the country bordering upon Green river,—scarcely less interesting than that of the Judith. These deposits pass up into the true lignite beds without any perceptible line of separation gradually losing their estuary character and ever after containing only land and freshwater shells. The lignite strata are chiefly remarkable for yielding in the greatest abundance, finely preserved vegetable remains. A few fragments of leaves of Dicotyledonous trees and silicified wood, with very impure lignite beds, are formed in some of the estuary deposits but no groups to indicate the great luxuriance of vegetation which must have existed during the accumulation of the lignite strata.

The geographical extension of the lignite deposits of the West is now a matter of the highest interest, and from what is already known, I am convinced that they will yet be found to cover a greater or less area on both sides of the main 'divide' of the Rocky Mountains, from the Arctic Sea to the Isthmus of Darien. The estuary and lignite beds seem also to have partaken equally with the older fossiliferous rocks, of the influence which elevated the mountain chains. Along the Laramie mountains, and from the Red Buttes to the 'divide' between Platte and Wind rivers along the Big Horn mountains the strata incline at very high angles 40° to 80° and in some instances are very nearly vertical. The true lignite strata seem to conform to the older fossiliferous rocks and to have been disturbed by the same influences that elevated the mountain ranges in the vicinity. These Tertiary beds extend over all the plain country to the north, and east of the Laramie mountains, far to the northward, beyond the limits of our explorations. Crossing the Wind River mountains, we find them largely developed high upon the western slope, dipping at a high angle, from the Wind River range on the one side, and the Wasatch and Green River mountains on the other.

Throughout the Wind River valley is a series of beds of great thickness which seem to be intermediate in their character between the true lignite beds and the White River Tertiary deposits. We first observed them gently inclined near Willow Springs on the North Platte and thence westward toward the Sweet Water mountains, and near the 'divide' between the North Platte and Wind River they reach a thickness of four hundred feet. From this 'divide' throughout the Wind River valley they occupy the greater portion of the country and though inclining in the same direction with the older strata the beds do not dip more than 1° to 5°. They differ from the other deposits in the great predominance of arenaceous sediments and in the absence of vegetable remains, but they contain fragments of turtles and

numerous fresh water and land shells of the genera *Helix*, *Planorbis*, *Vivipara*, etc. The entire thickness of these deposits may be estimated at from fifteen hundred to two thousand feet. From the fact that these deposits do not conform to the true lignite beds and that detached portions are seen lying upon the sides of the mountains but slightly inclined, while the corresponding beds are shown in the valley below, we infer that they were accumulated long before the mountains were raised to their present height or perhaps during the gradual process of elevation. This is especially shown at the upper end of the Wind River valley. Passing over the Wind River mountains we again see them holding the same position on the western slope and possessing the same lithological characters. While the lignite beds on the west side of the 'divide' incline at a large angle, the more recent beds although in some places occupying the very crest of the mountains, seldom incline more than 3 to 5 degrees.

The most interesting additional facts which we have obtained in regard to the White River Tertiary beds, are their geographical extension and the evidence of their age in relation to the lignite deposits. We can now show beyond a doubt that the former must have been accumulated long since the latter. We have ascertained that they extend southward along the Laramie Mountains to Willow Springs within ten miles of Cache la Poudre, that they also extend up the North Platte to the Box Elder creek, and even beyond are small outliers, showing that much has been removed by erosion. Passing over into the Laramie Plains we find at the source of the Box Elder and extending over to the head of Bates Fork a large development of this Tertiary and it also reaches far westward to the Medicine Bow mountains. We also know from the observations of Dr. Hines that it occupies a considerable area among the Sweet Water mountains extending over into the Green River valley. We have along the North Platte the overlapping of the White River beds upon the lignite strata, thus affording the evidence of superposition for their relative age. The same fact was noticed between the north fork of the Shyenne and the head of Cherry creek where beds of marl and limestone containing *Planorbis*, *Limnea*, etc., the same as are seen in the Bad Lands proper, repose upon true lignite Tertiary strata. Again, while the White River beds hold for the most part a horizontal position, those of the lignite Tertiary are often much disturbed. Near the Black Hills the former seem to have been elevated to a considerable heighth by the upheaval of the mountains, but they do not in any case incline more than 1° while north of the Black Hills the lignite beds dip 5° to 10°. Along the Platte I have seen the former inclining 5°, especially on La Bonte creek and about

fifteen miles east of the mouth of that creek. Often the beds seem to have been raised up several hundred feet above their original position, without inclination, resting upon the upturned edges of the lignite beds which we have before observed, partook equally of the disturbing influences which have given so great an inclination to the older fossiliferous rocks. Along the Big Horn mountains and the North Platte the lignite beds sometimes incline from the foot of the mountains 80° and often the influence of the elevatory power has affected them far out into the plain country.

In the above accounts of the Tertiary deposits of the West we have shown that the older members are clearly separated into four divisions exclusive of the Pliocene deposits of the Niobrara. Let us examine the evidence in regard to the age of these deposits. If we study the upper portions of Cretaceous formation No. 5 when not removed by the erosive power of water to any great extent, we then observe from the time we pass from No. 4 to No. 5 a gradual change in the sediments and other indications of a slow approach to shallow water, arenaceous sediments begin to take the place of argillaceous so that we have alternate thin layers of sand and clay, the sand continuing to increase until the upper part becomes a yellow ferruginous, coarse sandstone with most conspicuous examples of ripple-mark and oblique laminæ. As the waters of the Cretaceous sea were gradually receding, toward the Atlantic on the one side, and toward the Pacific on the other, remnants were left in the form of lakes, estuaries, etc., which now afford us the last indications of marine and brackish water deposits in the central portions of the West. In these deposits we have first a mingling of brackish and fresh-water forms, gradually passing up to pure fresh-water and terrestrial species, with no return to the marine condition again.

In the upper part of the Cretaceous formation No. 5, on the Moreau, we find the *Ostrea subtrigonalis*, and in the Judith deposits a form occurs in the greatest abundance which is undistinguishable from it.

We have also mentioned the fact that the fossils of upper part No. 5 seem to have existed upon the verge of the Tertiary period, that they sometimes present peculiar forms more closely allied to Tertiary types than Cretaceous and were it not for the presence of the genera *Baculites, Ammonites, Inoceramus*, etc., which are every where supposed to have become extinct at the close of the Cretaceous epoch, we would be in doubt whether to pronounce them Tertiary or Cretaceous. These facts would seem to indicate a foreshadowing of the Tertiary era and that the transition from one great period to the other was gradual and quiet, the change in the physical conditions being ultimately sufficient to

destroy the Cretaceous fauna and bring into existence that of the Tertiary. Again, in numerous localities where No. 5 is fully developed and a large thickness of Tertiary deposits is superimposed, so that near some of the mountain elevations I have found it difficult to draw the line of separation, no apparent physical break occurring in the sediments.

Will not these statements go far to show that the estuary deposits ushered in the dawn of the Tertiary epoch and induce the belief that they belong to the first part or Eocene period? This point is an important one to establish, on account of its bearing upon the history of the physical development of our western continent.

The estuary deposits soon lose their marine and brackish character and gradually pass up into the true Lignite strata, of purely freshwater origin, thence by a slight discordancy into the Wind River valley beds, which give evidence of being an intermediate deposit between the true lignite and White river Tertiary beds. Then come the White river bone beds which pass up into the Pliocene of the Niobrara by a slight physical break, and the latter are lost in the Yellow Marl or Lacs deposits. I have estimated the entire thickness of Tertiary rocks in the Northwest at from five to six thousand feet, and their interest will be appreciated when I venture to suggest that by thorough investigation they will doubtless reveal in a most remarkably clear manner the history of the physical growth and development, step by step, of the central portion of this continent. I shall treat this subject more fully in a future paper, and would refer to the forthcoming Report of Capt. Raynolds for the details of the facts sustaining my opinions.

We have no evidence, so far as I know, of long continued deep-water deposits in the west, until far up in the Cretaceous period. If we examine the Potsdam sandstone we shall find that where it reaches its greatest force, the lower portion is composed of an aggregation of quartz pebbles cemented with siliceous matter, and as we pass upward we find it arranged in thin layers quite compact with fucoidal markings, ripple-mark, &c. Everywhere are most abundant examples of oblique laminæ of deposit, and ripple and wave-markings—evidences of shallow waters.

During the long period that elapsed between the deposition of the earliest part of the Silurian epoch and the commencement of the Carboniferous, we have reason to believe that dry land prevailed over a large portion of the west. The Carboniferous epoch commences with thin layers of arenaceous deposits gradually passing up into homogeneous siliceous and calcareous beds. The latter are never more than from twenty to fifty feet in thickness, and then the arenaceous sediments begin again to predominate and all the proofs of shallow as well as turbulent waters are shown. We then pass up through the red arenaceous de-

posits and Jurassic beds, and find no rocks that indicate deep water deposition. Cretaceous formation No. 1 commences in many places with a considerable thickness of an aggregation of water-worn pebbles passing up into thin alternate layers of arenaceous and argillaceous sediments with thick beds of sandstone with ripple markings and oblique laminæ, then gradually ceases in No. 2 and through Nos. 2, 3 and 4, the sediments indicate that they were accumulated in comparatively deep and quiet waters. No. 2 is a black plastic clay, No. 3 grey marl, and No. 4 a dark indurated sometimes laminated clay with many calcareous concretions. In No. 5 we gradually approach indications of shallow water until dry land appears, as already stated.

It will not be possible at this time to mention in detail all the oscillations of surface and other physical changes to which we have reason for supposing the country was subjected during all these periods. It is sufficient for our present purpose to show that except during the middle Cretaceous epoch no long continued periods of quiet water prevailed in these ancient western seas.

The evidence appears to me to point to the conclusion that a much milder climate prevailed throughout the western portions of our continent, during a greater part of the Tertiary period than that which exists in the same latitudes at the present time. The organic remains appear to indicate a subtropical climate or one similar to that of our Gulf States. Near the close of the Cretaceous epoch the waters of the great Cretaceous sea receded toward the present position of the Atlantic on the one side and toward that of the Pacific on the other, leaving large areas in the central portions of the west, dry land. These areas were of course proximity to the sea and comparatively but slightly elevated above the ocean waters. In regard to the Mollusca which have been found quite abundantly entombed in the lignite-bearing strata, it is an interesting fact that the most nearly allied living representatives of many of these species are now found inhabiting the streams of Southern Africa, Asia, China and Siam, apparently indicating the existence of a tropical climate in these latitudes at as late a period as the Tertiary epoch.*

Again, the luxuriance of the flora which has been so perfectly preserved in the lignite strata of the West point to the same conclusion. It is true that until recently no species have been found which belong exclusively to a tropical vegetation, but during our last expedition we obtained a species of true fan palm, very closely allied to *Sabal lamonis*, figured by Dr. Heer in his "Flora Tertiaria Helvetiæ." "The most northern limit of palms is that of *Chamærops palmetto*, in North America in lat. 34°–36°, and of *Chamærops humilis* in Europe, near Nice, in 43°–44° N.

* See Memoir by F. B. Meek and F. V. Hayden, in Proc. Pa. Acad., June, 1856.

lat."* The true palms of our present day are considered as having their native land within the tropics. That this or a similar condition of climate continued throughout the accumulation of the Wind River valley deposits may be inferred from their Molluscan remains which are more nearly allied to tropical forms.

Again, we have in the West, as before mentioned, a vast area occupied by the lignite-bearing strata. There are from thirty to fifty beds of lignite varying in thickness from one inch to seven feet. Over all this vast area there are at the present time no large forests, no timber except that which skirts the streams. We now know that during the Tertiary period vast forests of timber must have covered many portions of the West from the abundance and variety of the vegetable remains preserved in the rocks. Silicified trunks of trees, fifty to one hundred feet in length and two to four feet in diameter, and stumps which indicate gigantic forest trees occur abundantly over hundreds of square miles along the Missouri and Yellow Stone rivers. Prof. Henry and other meteorologists have arrived at the conclusion from a vast number of well authenticated facts that the absence of forest trees on the great prairies of the far west is due to the want of moisture which is well known to prevail all along the eastern slope of the Rocky Mountains. The prevailing winds are now known to come from the west, and as the currents of air ladened with moisture from the Pacific ascend the western slope of the mountains, become condensed and deposit their burdens for the most part before reaching the eastern slope.

Prof. Henry, in his paper on Climatology contributed to the Patent Office Report for 1856, says: "the return westerly current, sweeping over the Pacific Ocean, and consequently charged with moisture, will impinge on the Coast range of mountains of Oregon and California, and, in ascending its slopes, deposit moisture on the western declivity, giving fertility and a healthful climate to a narrow strip of country bordering on the ocean, and sterility to the eastern slope. All the moisture however will not be deposited in the passage over the first range, but a portion will be precipitated on the western side of the next, until it reaches the eastern elevated ridge of the Rocky Mountain system, when, we think, it will be nearly if not quite exhausted." We are now supposing that the climatic conditions, winds, currents of air, &c., did not differ to any great extent during the Tertiary epoch from those which prevail in the same latitudes at the present day. We therefore venture the suggestion that up to the time of the accumulation of the middle Tertiary deposits the lofty barrier of the Rocky Mountains did not exist.

* Lindley's Vegetable Kingdom, p. 136.

Washington, D. C., January 20, 1861.

ART. XXII.—*Remarks on the Atomic Weights of the Elements;* by WOLCOTT GIBBS, M.D., Prof. of Chemistry and Physics in the Free Academy in New York.

IN the present communication I shall endeavor to show that if the atomic weights of oxygen, sulphur and carbon are taken, respectively, as 16, 32 and 12, those of a majority of the other elements must be doubled. I do not at present adopt the view in question; my object is simply to point out the logical consistency of the change. For the sake of convenience and precision of language I shall employ the terms atom, molecule and equivalent, in the sense in which they are understood by the chemists of the new or unitary school.* An atom of any element is the least quantity of that element which can exist in combination: a molecule is the least quantity which can exist in the free state. The definitions of atomic and molecular weights flow at once from those of atom and molecule. The equivalents of bodies are the relative quantities which replace each other in actual or ideal substitutions; they may correspond to atoms or to molecules, or may bear a simple numerical relation to either of these. The atomic weights of carbon, oxygen and sulphur are now generally considered to be respectively 12, 16 and 32, chiefly upon the following grounds:

1. In all volatile organic compounds the constitution of which has been accurately determined, the number of atoms of these elements is always even, if we consider the weights of the atoms to be respectively 6, 8 and 16. Provided that all such compounds are assumed to correspond to 2 vols. of vapor (H=1).

2. Purely chemical considerations appear to show that in organic compounds, independently of any assumption as to vapor-volumes, the number of atoms of carbon, oxygen and sulphur is always even.

3. When oxygen or sulphur replace hydrogen in organic compounds, 2 units of weight of hydrogen are replaced by 16 of oxygen or 32 of sulphur; 4 units of hydrogen by 32 of oxygen, and so on; in no case is one unit of weight of hydrogen replaced by 8 of oxygen.

4. The least quantity of oxygen or sulphur set free in any reaction is either 32 or 64, or is some multiple of 32 or 64. In like manner the least quantity of oxygen or sulphur which reacts with any compound body is a multiple of 16 or 32 by an even number.

The assumption is now generally made that the molecules of all substances in the gaseous state occupy the same volume:

* See for example Kekulé, Lehrbuch der Organischen Chemie, i, 97, Erlangen, 1859.

from this it follows that in the greater number of cases two atoms unite to form one gaseous molecule. The difficulty which formerly existed in the case of sulphur has been completely removed by the researches of Deville and Troost, and of Bineau, who have shown that the volume occupied by 16 parts of sulphur in the form of perfect gas is $\frac{1}{2}$, and not $\frac{1}{3}$ of that occupied by 1 part by weight of hydrogen. In the case of those substances the vapor-densities of which correspond to *four* volumes, it appears probable that decomposition into two 2-volume molecules occurs, so that the observed vapor-densities are the sums of the densities of the constituent molecules. Thus sal-ammoniac* in the form of vapor is HCl and NH_3, these constituents recombining at a lower temperatute to NH_4Cl. In this manner, among others Kopp† and Hofmann‡ have shown that it is unnecessary to admit the existence of 3-volume, 4-volume and 6-volume vapors. There exists however at least one exception to the law now generally admitted that, in the case of the elements, one molecule consists of two associated atoms. The vapor-density of phosphorus, even at a temperature of 1040° C., corresponds to $\frac{1}{2}$ vol., the atomic weight being taken as 31. Since sulphur, which is less volatile than phosphorus, is a perfect gas even at 860°, we cannot admit that the case is otherwise with phosphorus, or reasonably suppose that the vapor-density would correspond to one volume if determined at a still higher temperature. We must therefore admit that the molecule of phosphorus corresponding to 2 vols. of vapor contains 4 atoms, and not 2 like that of nitrogen, while nothing is more certain than that the atomic weights of phosphorus and nitrogen are respectively 31 and 14. In like manner the vapor-density of arsenic appears also to correspond to $\frac{1}{2}$ volume only, though it has not yet been determined at temperatures very far above the boiling point.

If now we admit that the molecules of all substances occupy 2 vols. in the gaseous state, and if the reasoning which has led chemists to double the old atomic weights of carbon, oxygen, sulphur, &c., be correct, it follows that the atomic weights of the greater number of the elements must be doubled. For we find:—

1. That nearly all volatile inorganic oxyds, chlorids, oxychlorids &c. contain in 2 vols. of vapor (H=1) two or four received equivalents of metal or radical. Thus the compounds whose formulas are now usually written $SiCl_2$, $TiCl_2$, ZCl_2, $SnCl_2$,

* Deville and Troost have shown that sal-ammoniac corresponds to 4 vols. of vapor even at a temperature of 1040° C. At this temperature ammonia must be resolved into its elements, and its vapor-density ought to correspond to 6 vols. instead of 4. The explanation in the text is therefore not applicable to all cases. Comptes Rendus, xlix, 239.

† Ann. Chemie und Pharmacie, cv, 390.

‡ Comptes Rendus, xlix, 781.

$HgCl$, Hg_2Cl, $HgBr$, Hg_2Br_2, Fe_2Cl_3, Al_2Cl_3, Al_2I_3, Al_2Br_3, CrO_2Cl, must be written Si_2Cl_4, Ti_2Cl_4, Z_2Cl_4, Sn_2Cl_4, Hg_2Cl_2, Hg_4Cl_2, Hg_2Br_2, Hg_2I_2, Fe_4Cl_6, Al_4Cl_6, Al_4I_6, Al_4Br_6, $Cr_2O_4Cl_2$, in order to correspond to 2 vols. of vapor.

2. All volatile metals and metallic oxyds contain two or four received equivalents in 2 vols. of vapor. Thus the vapor-densities of mercury and cadmium represent the molecular weights Hg_2 and Cd_2. Arsenous and osmic acids correspond in the form of vapor to the formulas As_2O_6 and Os_2O_8.

3. All volatile compounds of metals with organic radicals contain an even number of equivalents of metal in 2 vols. of vapor, excepting only those in which triatomic metals occur. Thus we have corresponding to 2 vols. of vapor the formulas:—

$\left.\begin{matrix}C_2H_3\\C_2H_3\end{matrix}\right\}Zn_2$, $\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}Zn_2$, $\left\{C_2H_3\right\}_4Sn_2$, $\left\{C_4H_5\right\}_4Sn_2$,

$\left.\begin{matrix}(C_2H_3)_2\\(C_4H_5)_2\end{matrix}\right\}Sn_2$, $\left.\begin{matrix}(C_4H_5)_2\\Cl_2\end{matrix}\right\}Sn_2$, $\left.\begin{matrix}(C_4H_5)_2\\Br_2\end{matrix}\right\}Sn_2$, $\left.\begin{matrix}(C_4H_5)_3\\Br\end{matrix}\right\}Sn_2$,

$\left.\begin{matrix}(C_4H_5)_3\\Cl\end{matrix}\right\}Sn_2$.

4. The volatile compounds of the triatomic radicals, nitrogen, phosphorus, arsenic, antimony, bismuth and boron, contain in 2 vols. of vapor only one received atomic weight of the radical. Thus we have the compounds:—

NH_3, PCl_3, $AsCl_3$, $SbCl_3$, $BiCl_3$, BCl_3, $P(C_4H_5)_3$, $As(C_4H_5)_3$, $Sb(C_4H_5)_3$, $B(C_4H_5)_3$, $BO_3\,3C_4H_5O$, &c. &c.

To this there are exceptions. Thus we have corresponding to 2 vols. the formulas:—

As_2O_6, $\left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2$, $\left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2O_2$, $\left.\begin{matrix}(C_2H_3)_2\\(C_2H_3)_2\end{matrix}\right\}As_2S_2$.

5. The specific heats of the atoms of nearly all the elements are equal if the molecule is in each case referred to 2 vols. of vapor.*

If now we consider it proved from the above considerations that the molecular weights of carbon, silicon, tin, titanium and zirconium, correspond in the gaseous form to 2 vols., and that these elements are tetratomic, it follows from analogy that certain other elements are also tetratomic, and we have the group:—

Carbon,	12	1·68	Lead,	208	6·52
Silicon,	28	—	Palladium,	108	6·40
Zirconium,	44	—	Rhodium,	102	5·62
Titanium,	48	—	Ruthenium,	106	—
Niobium,	96	—	Platinum,	198	6·40
Tantalum,	136	—	Iridium,	196	7·00
Tin,	116	6·52	Osmium,	194	5·92

* The only exception to this law occurs in the case of carbon, and cannot at present be explained.

The first column of numbers giving the atomic weights, the second the atomic heats or the products of the atomic weights into the specific heats. It is possible that thorium belongs to the tetratomic group, as thoria appears to be ismorphous with stannic acid, Sn_2O_4. Lead is placed in this group from the analogy of the compounds which it forms with ethyl, methyl, &c. to stannethyl, &c.: it appears however like tin, palladium, ruthenium, platinum, rhodium, iridium and osmium to be also diatomic; the so-called protoxyds having the formulas Pb_2O_2, Sn_2O_2, &c. For similar reasons we admit the existence of 6 triatomic elements, namely:—

Nitrogen,	14	—	Antimony,	120	6·11
Phosphorus,	31	5·85	Bismuth,	208	6·41
Arsenic,	75	6·10	Boron,	11	—

The diatomic elements, according to the reasoning above mentioned, will be 30 in number, and may be arranged in natural families, as follows:—

Oxygen,	16	—	Iron,	56	6·38
Sulphur,	32	6·48	Manganese,	54	—
Selenium,	80	6·08	Cobalt,	60	6·42
Tellurium,	128	6·08	Nickel,	58	6·28
			Chromium,	52	—
Magnesium,	24	—	Aluminum,	27·5	5·88
Calcium,	40	—	Zinc,	65	6·24
Strontium,	88	—	Cadmium,	112	6·36
Barium,	136	—	Copper.	63	6·04
			Uranium,	120	—
Cerium,	92	—	Mercury,	200	6·40
Lanthanum,	94	—			
Didymium,	96	—	Molybdenum,	96	6·91
Yttrium,	—	—	Tungsten,	184	6·67
Erbium,	—	—	Vanadium, ?	138	—
Terbium,	—	—			
Glucinum,	10	—			
Thorium, ?	118	—			

This classification into natural families appears to me to represent the present state of our knowledge, though the position of several elements must be regarded as doubtful.* The monatomic elements are only 10 in number; they may be arranged in three groups:

Chlorine,	35·5	—	Hydrogen,	1	—	Silver,	108	6·16
Bromine,	80	−6·74	Lithium,	7	—	Gold,	197	6·38
Iodine,	127	6·88	Sodium,	23	6·71			
Fluorine,	19	—	Potassium,	39	6·60			

* There is reason to believe that vanadium belongs with boron to the nitrogen group.

It is however to be remarked that, of the other elements, at least two, namely copper and mercury, are monatomic in certain combinations, as for example, in Cu_2Cl and Hg_2Cl. It is true that we may write these formulas Cu_4Cl_2 and Hg_4Cl_2, in which case we have two additional diatomic forms of copper and mercury with the atomic weights 126 and 400 respectively. This mode of viewing the subject obliges us to admit atomic heats represented nearly by the number 12, or twice as high as in the case of the other elements, and appears therefore less simple than that first stated.

In like manner all the elements belonging to the tetratomic group which form protoxyds, &c., may be regarded as tetratomic and diatomic; this will add at least eight to the number of diatomic elements. Finally, in the sesquioxyds and similar compounds two received atoms of iron, manganese, chromium, aluminum, &c., must be regarded as forming a single triatomic atom. Limpricht* and Frankland† admit the existence of pentatomic elements, including the nitrogen group in this class, but this view is not generally adopted, and in the present state of our knowledge a primary division of the 60 elements into four classes, the monatomic, diatomic, triatomic and tetratomic elements, appears to be sufficient.

From the above it appears that of the 60 elements now known to chemists, the received atomic weights of 50 at least must be doubled, if we admit the correctness of the reasoning which has led many chemists at the present day to double the atomic weights of carbon, oxygen and sulphur. Wanklyn‡ and Wurtz§ have already suggested the propriety of doubling the equivalents of zinc and tin, and by analogy, of several other metals, while Cannizzaro‖ has adduced the specific heats of the atoms with other arguments in favor of the same change. Wurtz compares oxyd of zinc Zn_2O_2, with oxyd of ethylene $(C_4H_4)O_2$; the hydrate of oxyd of zinc will then correspond to glycol, $\left.\begin{matrix}Zn_2\\H_2\end{matrix}\right\}O_4$. In the same way we may consider hydrate of sesquioxyd of iron as corresponding to glycerine, $\left.\begin{matrix}\overset{\prime\prime\prime}{Fe}_2\\H_3\end{matrix}\right\}O_6$ to $\left.\begin{matrix}\overset{\prime\prime\prime}{C}_6H_5\\H_3\end{matrix}\right\}O_6$, Fe_2 being here triatomic.

Should the further progress of the science show that the views above mentioned are the most simple and consistent expression

* Limpricht. Lehrbuch der Organischen Chemie, 1te Abth., 8.

† Quarterly Journal of the Chemical Society, vol. xiii, Nos. 2 and 3.

‡ The same, vol. xiii, p. 124.

§ Ann. de Chimie et de Physique, lx, 239, and Repertoire de Chimie pure, ii, 405.

‖ Il nuovo Cimento, vii, 321. I have not seen the original paper and quote at second hand from the Jahresbericht of Kopp and Will for 1858, p. 12.

of all the facts, it will be desirable to return to the notation of Berzelius slightly modified, that is to say, it will be better to halve the atomic weights of hydrogen and the other monatomic and triatomic elements, and denote the atomic weights of carbon, oxygen, sulphur, zinc, &c., by the numbers 6, 8, 16, 32,5, &c., respectively. In this manner while the formulas are written with precisely the notation of the new school, the numbers actually employed in the great majority of calculations will be those which have been sanctioned by longest usage, and which are most convenient for practical purposes. The atomic weights of hydrogen, chlorine, potassium, and the other monatomic elements, will be in each case one half of the old equivalent, while the molecular weights will correspond with the old equivalents. Thus we shall have:—

Hydrogen,	$\frac{1}{2}$	1	Oxygen,	8	16
Chlorine,	17·75	35·5	Carbon,	6	12
Bromine,	40	80	Zinc,	32·5	65
Potassium,	19·5	39	Iron,	28	56
Nitrogen,	7	14	&c. &c.		

in which table the first column gives the atomic and the second the molecular weights.

The formula of water thus becomes H_2O and its atomic weight 9; caustic potash is $\left.\begin{matrix}K\\H\end{matrix}\right\}O$ and its atomic weight 28; oxyd of zinc will be ZnO and its atomic weight 40·5; chlorhydric acid will be HCl and its atomic weight 18·25. The dashed symbols $\dot{H}$, $\dot{Cl}$, $\dot{K}$, &c., may also be employed, as in the Berzelian notation and would in many cases be extremely convenient.

All the typical formulas now so generally employed will be written as at present, the actual weights only being changed. The general acceptance of the views of the new school would be greatly facilitated by the adoption of the system of atomic weights here proposed.

In another paper I propose to discuss the question of the basicity of the elements with other points of special theoretical interest.

New York, Jan. 12th, 1861.

ART. XXIII.—*Abstract of a Meteorological Journal for the year* 1860, *kept at Marietta, Ohio:* lat. 39° 25′ N., and long. 4° 28′ W. of Washington City; by S. P. HILDRETH.—[Thirty-fourth annual report.]

MONTHS.	THERMOMETER.			Fair days.	Cloudy days.	Rain—inches.	Prevailing Winds.	BAROMETER.		
	Mean.	Maximum.	Minimum.					Maximum.	Minimum.	Range.
	°		°							
January,	32·66	61	3	15	16	3·25	S.S.W., & N.	30·00	29·05	·95
February,	35·00	71	2	16	13	1·25	S.S.W., & N.W.	29·75	28·55	1·20
March,	44·13	71	16	18	13	1·08	S.S.E., & N.W.	29·55	29·00	·55
April,	54·30	83	24	13	17	5·30	S.S.E., & N.	29·75	28·65	1·10
May,	65·50	91	39	13	18	2·88	E.S.E., & N.	29·58	29·10	·43
June,	68·03	94	44	15	15	2·01	S.S.E., & W.	29·70	28·83	·87
July,	73·68	95	49	16	15	5·87	E.S.E., & S.W.	29·60	29·08	·52
August,	72·23	95	48	18	13	4·14	E.S.E., & N.	29·58	29·20	·38
September,	62·10	88	38	15	15	3·26	S.E., & N.	29·70	29·15	·55
October,	62·17	84	33	16	15	4·35	S.S.W. & N.	29·65	28·95	·70
November,	40·29	79	10	15	15	4·01	S.W., W., & N.W.	29·60	28·85	·75
December,	30·13	51	11	7	24	2·08	W.N.W., & E.	29·85	28·73	1·12

The mean temperature of the year is 53°·35. The amount of rain and melted snow is 39·58 inches.

Remarks on the year 1860.—This year has been characterized by several uncommon events in the meteorology of the climate, such as wide-spreading and destructive storms, with tornadoes of unprecedented violence sweeping every thing in their course from the face of the earth with the impetuosity and force of gunpowder, raising the question whether its main power was not derived from electricity, rather than from the winds. Some portions of the valley of the Ohio and of the Mississippi suffered immensely from these storms in the months of May and June, which periods seem to be more liable to such outbreaks of the elements than any other portions of the year. Setting aside these events, the year has been one of uncommon fertility and productiveness. The crops of grain and fruit were abundant and never excelled in quantity since the first settlement of the country. The health of the adult portion of the population has been good, uncommonly exempt from fevers; in place of which has prevailed a new form of the old and well known scarlet fever, or 'putrid sore throat,' chiefly confined to children, but of a most fatal and destructive type. Like the cholera, it appears to be epidemic in its character, and after a certain period will run its course and disappear from the land.

TEMPERATURE, AND REMARKS ON THE SEASONS.

Winter months.—The mean temperature of the winter is 32°·95, proving it to have been a very mild one, as it is sometimes as low as twenty-six degrees. The first week in January was the coldest of the winter, the temperature being below freezing all the time, and on the fifth at three degrees below zero. The Ohio river was closed for a few days above Marietta, but soon opened, leaving the navigation for steamboats free, the remainder of the winter. In ponds and the mouths of creeks, ice formed of the thickness of six or eight inches, and a plentiful supply was procured for summer use of this needful article of comfort. The greatest depth of snow, at any one time, was three inches, on the 21st of December.

Spring.—The mean of the spring months was 54°·64, which is about the average for a series of years. This season is called earlier or later from the blossoming of a certain class of trees, especially fruit trees, the peach and apple being the standard. The former did not bloom until the eighth of April, and the latter on the fifteenth of that month, which may be called about the mean time, although the period varies as much as twenty-five or thirty days in some years. It was a spring of mild, pleasant temperature, and favorable to the growth and health of the vegetable kingdom, but marked by several unusual phenomena in the meteorological department of nature. The early part of April was attended with excessive rains, producing floods in the Ohio and Muskingum rivers, overflowing the bottom lands to a great depth, and higher by four feet at Dresden and two feet at Zanesville, than ever before. The main source of the flood was in the rivers that fall into the Ohio, on the north side, as the Scioto, Muskingum, Beaver and Alleghany. The southern affluents were not very high, or the water would have equalled that of 1832. But little damage was done below Marietta, which, standing at the junction of the Muskingum with the Ohio, suffers more than any other point ten miles above or below that place. At this town the water was four feet below the flood of 1832, but twelve inches higher than any other one.

Great meteor of May, 1860.—On the first day of May, about twenty minutes before one o'clock, P. M., a tremendous explosion was heard at Marietta, like the discharge of a piece of heavy artillery, the sound coming from the north. It was found to proceed from the explosion of an aërolite or meteor, which fell at a place about fifty miles north of Marietta, and twenty east of Zanesville. Its course with a description of the accompanying phenomena has been given in this Journal by Profs. Andrews and Evans of the Marietta College, and Dr. J. L. Smith; the first and last named gentlemen having personally visited the locality

where it fell, a few days subsequently, and minutely examined all the attending circumstances noted by the inhabitants in the vicinity. One of the largest fragments, weighing over one hundred pounds, was purchased and placed in the cabinet of Marietta College. Appearing, as this meteor did, in the middle of the day, when hundreds of spectators were in situations to see it, the history of its course and appearance has happily been made out more accurately and satisfactorily than that of any other which has visited North America.

Great storm of the 21st of May.—On Monday, the twenty-first day of May, the valley of the Ohio was visited by one of the greatest storms or tornadoes ever experienced since the settlement of the country. Commencing west of the Mississippi river, it swept over a space not less than six or seven hundred miles in length by fifty or sixty in breadth, following generally the course of the Ohio river, or from the southwest to the northeast. I do not know the hour of its commencement, but it was at Louisville, Ky., by two o'clock, P. M., at Cincinnati by half past three, at Portsmouth by half past four, and at Marietta about half past five, travelling at the rate of eighty or one hundred miles an hour, far exceeding in rapidity that of any railway train. Its progress was marked by desolation and ruin, in the destruction of buildings, fences, trees and boats. Of the latter, many coal boats were sunk and the navigators drowned. Several hundred lives were lost. Steamboats suffered less, as by their motive power they were able to gain a more sheltered position on the bends of the river. Louisville, Cincinnati and Portsmouth suffered more than any other towns, being larger and more fully exposed to the fury of the storm. Marietta suffered but little, the force of the tornado being expended before it reached that place. In its full force it was attended with thunder, lightning, hail and torrents of rain, pouring from the clouds more like a cataract than rain. The air was filled with leaves, fragments of branches and broken pieces of buildings, which, with the mist, produced a darkness equal to that of a cloudy night, requiring the aid of candles to go about the house. The violence of the storm at any one place did not last over half an hour. At Marietta the day was cloudy with a brisk breeze from the southwest in the forenoon, in the afternoon it veered to the south. At 5 P. M. heavy dark clouds appeared in the west, with a good deal of commotion and some thunder. At half past five it began to rain a little. A quarter before six, wind very violent from the southwest and west, with hard rain, blowing steadily and not in gusts as in ordinary storms, lasting about twenty minutes. As soon as the rain ceased, the sky or hazy clouds in the west and southwest put on a deep orange or copper color, and after seven until dark, a brilliant red, like the rays of light

in the aurora borealis. The night following was calm and clear. The mercury in the barometer, in the forenoon, was 29·10, and kept rising during the violence of the tempest, being at 29·15 at 5 P. M., and at 29·23 at 9 o'clock. At Wheeling, Va., 80 miles southeast of Marietta, there was only an ordinary gale, its force being spent before reaching there. No similar tornado has visited the valley of the Ohio since Sunday, the 28th day of May, 1809. This struck Marietta about 4 o'clock P. M. with more violence than in 1860. There was little or no rain or thunder; several houses were unroofed and some blown down, with immense destruction of forest trees. It was greater in breadth and probably as extensive as that of this year. I was living in the town at that time and witnessed its ravages. Brown's Cincinnati Almanac for the year 1810 contains the only printed account of it that I have seen; but probably the newspapers of that period noticed it, as there were then nine or ten published in Ohio.

Summer.—The mean of the summer months was 71°·31, which is a full average for this season of the year. Heat and moisture were distributed by a beneficent Providence in due season and in quantities fully adequate to the wants of vegetation, producing one of the most abundant harvests in all the various varieties of cereal productions common to this climate. In some of the southern counties whole fields of wheat were destroyed by that pernicious insect, *Tinea granella*, after it had attained its full growth. This miller is a different insect from the Hessian fly; the ravages of the former are confined to the grain, where it deposits its eggs when in the milk, while the 'fly' makes its attacks on the culm, laying its eggs in the autumn and spring. This miller in some districts, especially in Washington county, was very injurious, its larvæ devouring the grain in whole fields, leaving none for the farmer. Happily its ravages were limited. A remedy is said to be found in a new variety of wheat, which the Tinea does not molest, and which is already coming into cultivation. The meadows furnished an abundance of grass, and the pastures were green until late in the autumn. In some fields the potatoes suffered from the disease called 'the rot,' but generally the crop was abundant and good.

Autumn.—The mean of the autumnal months was 54°·85, a temperature adequate to the wants of the season. Indian corn, the main crop of the valley of the Ohio, and of more importance to the farmer than that of any other grain, was very abundant in quantity and excellent in quality. It ripened early, and was ready to be cut up by the twentieth of September. This year, from the supply of rains at the right time, the crops on the hills and uplands were nearly as good as in the rich bottom lands of the rivers, while on the latter, the heavy deposits of vegetable mould left by the overflow in April added unusual fer-

tility to the soil, producing crops of corn from eighty to one hundred bushels an acre, remunerating the husbandman for his extra labor in replowing and replanting his fields. Fruit of all kinds was abundant, especially apples and peaches. All the smaller fruits were in great perfection. Grapes matured without much loss from mildew or insects. Melons were never better or more plentiful. The forests abounded in acorns and nuts, bending their branches under their uncommon load. On every department of the vegetable kingdom the God of nature has bestowed his blessing in a manner rarely before witnessed.

Floral calendar.—February 24th, the Robin appears in flocks; 27th, Bluebirds.—March 1st, Blackbirds in flocks, yellow crocus in bloom; 7th, flocks of the cherry lark, White Crocus; 14th, Persian Iris; 16th, blue Crocus; 20th, Crown Imperial nearly open; 25th, Sugar maple; 26th, Golden bell or Forsythia viridis; 28th, Magnolia conspicua ready to open, but injured by the late frosts.—April 1st, Primrose in bloom; 3d, Hyacinth; 6th, Peach partly open in warm exposures; 7th, Sanguinaria canadensis; 8th, Peach in full bloom, Plum trees, Pears and Cherries; 11th, white Narcissus; 15th, Apple tree in bloom; 16th, Redbud or Circis canadensis, Hydrastis canadensis; 18th, Cornus Florida; 23d, Lilac; 26th, Tulips in bloom.—May 1st, Black Haw tree in bloom; 2d, Quince tree, Harebell; 5th, Native crab apple; 7th, Horse chestnut; 8th, Wigelia rosea; 11th, Harrison yellow rose and fragrant Syringa; 13th, Locust or Pseudoaensia; 14th, Prunus Virginiana; 25th, Syringa Philadelphia.—June 10th, White Lily; 17th, Catalpa tree; 30th, Juneating apple ripe.—July 5th, Amaryllis formosa; 7th, Blackberry ripe; 8th, American broom in bloom; 12th, Chestnut tree.—August 1st, Green gage plum ripe, and Summer Virgaleu pear; 8th, Watermelons ripe in open ground; 16th, Sweet potatoes in market.

Marietta, Ohio, January 1, 1861.

ART. XXIV.—*On the Theory of Types in Chemistry;* by T. STERRY HUNT, F.R.S.

IN the *Annalen der Chimie und Pharmacie* for March, 1860 (cxiii, 293), Kolbe has given a paper on the natural relations between mineral and organic compounds, considered as a scientific basis for a new classification of the latter. He objects to the four types admitted by Gerhardt, (namely, hydrogen, hydrochloric acid, water and ammonia,) that they sustain to organic compounds only artificial and external relations, while he conceives that between these and certain other bodies there are natural relations having reference to the origin of the organic spe-

cies. Starting from the fact that all the carbon compounds found in the vegetable kingdom are derived from carbonic acid with the concurrence of water, he proceeds to show how all the bodies of the carbon series may be deduced from an oxyd of carbon, which is either carbonic acid, carbonic oxyd, or the hypothetical C_2O.

When in the former (C_2O_4) we replace an atom of oxygen by one of hydrogen we have C_2O_3H, or anhydrous formic acid; the replacement of a second equivalent would yield $C_2O_2H_2$, or the unknown formic aldehyd; a third, C_2OH_3, the oxyd of methyl, and a fourth, C_2H_4, or formene. By substituting methyl, C_2H_3, for one or more atoms of hydrogen in the preceding formulas we obtain those of the corresponding bodies of the vinic series, and it will be readily seen that by introducing the higher alcoholic radicals we may derive from C_2O_4 the formulas of all the alcoholic series. A grave objection to this view is however found in the fact that while the anhydrid may in this way be made the type of the aldehyds, acetones and hydrocarbons, it becomes necessary to assume the hypothetical C_2O_4HO as the type of the acids and alcohols. Oxyd of carbon, C_2O_2, is according to Kolbe to be received as the type of hydrocarbons like olefiant gas, ($C_2H.C_2H_3$,) while C_2O, in which ethyl replaces oxygen is C_6H_5 or lipyle, the supposed triatomic base of glycerine.

The monobasic organic acids are thus derived from a single molecule of carbonic acid, while bibasic acids like the succinic are by Kolbe deduced from a double molecule, and tribasic acids like citric from a triple molecule, C_6O_{12}. He moreover compares sulphuric acid to carbonic acid and deduces from it by substitution the various sulphuric organic compounds. Ammonia, phosphuretted and arseniuretted hydrogen are regarded as so many types, and by an extension of his view of the replacement of oxygen by electro-positive groups the ethylids like ZnEt, $PbEt_2$, and $BiEt_3$, are by Kolbe assimilated to the oxyds, ZnO, PbO_2, and BiO_3.*

Ad. Wurtz, in the *Repertoire de Chimie Pure* for October, 1860, has given an analysis of Kolbe's memoir (to which, not having the original before me, I am indebted for the above sketch), and follows it by a judicious criticism. While Kolbe introduces as types a number of mineral species, including the oxyds of carbon, sulphur, and the metals, Wurtz would maintain but three, hydrogen (H_2), water (H_2O_2), and ammonia (NH_3), and these three types, as he endeavored to show in 1855, represent different degrees of condensation of matter. The molecule of hydrogen, H_2 or M_2, corresponding to four volumes, combines with

* See on this subject Dr. Frankland's late excellent lecture on Organo-metallic bodies in the Quarterly Journal of the Chemical Society, July, 1860, Nos. L, LI.

two volumes of oxygen (O_2) to form four volumes of water, and may thus be regarded as condensed one-half in its union with oxygen, and derived from a double molecule, M_2M_2. In like manner four volumes of ammonia, NH_3, contain two volumes of nitrogen and six of hydrogen, which being reduced to one-third corresponds to a triple molecule, M_3M_3, so that these three types and their multiples are reducible to that of hydrogen more or less condensed.—(Wurtz, *Ann. de Chimie et de Physique*, [3], xliv, 302.)

As regards the rejection of water as a type of organic compounds and the substitution of carbonic acid, founded upon the consideration that these bodies in nature are derived from C_2O_4, Wurtz has well remarked that water, as the source of hydrogen, is equally essential to their formation, and farther that the carbonic anhydrid, like all other anhydrous acids, may be regarded as a simple derivative of the water type. Having then adopted the notion of referring a great variety of bodies to a min ral species of simple constitution, water is to be preferred to carbonic acid, 1st, because we can compare with it many mineral compounds which can with difficulty be compared with carbonic acid, and 2d, because the two atoms of hydrogen in water being replaceable singly, the mode of derivation of a great number of compounds (acids, alcohols, ethers, etc.) is much more simple and natural than from carbonic acid. As Wurtz remarks, Kolbe has so fully adopted the theory of types that he wishes to multiply them, and even admits condensed types, which are, however, molecules of carbonic acid and not of water; "he combats the types of Gerhardt and at the same time counterfeits them."

Thus far we are in accordance with Wurtz, who has shown himself one of the ablest and most intelligent expounders of the doctrine of molecular types as above defined, now almost universally admitted by chemists. He writes, "to my mind the idea of referring to water, taken as a type, a very great number of compounds is one of the most beautiful conceptions of modern chemistry;" and again he declares the idea of regarding water and ammonia as representatives of the hydrogen type more or less condensed, to be so simple and so general in its application that it is worthy "to form the basis of a system of chemistry." (*Repertoire de Chimie Pure*, 1860, pp. 356–359.)

We have here two important conceptions; the first is that of hydrogen and water regarded as types to which both mineral and organic species may be referred, and the second is the notion of condensed and derived types, according to which we not only assume two or three molecules of hydrogen, water or ammonia as typical forms, but even look upon water as the derivative of hydrogen, which is itself the primal type.

As to the history of these ideas, Wurtz remarks that the proposition enunciated by Kolbe that "all organic bodies are derived from mineral compounds, from which they take their origin, in part directly, by processes of substitution of great simplicity," is not new, but "known in the science for about ten years. Williamson was the first who said 'alcohol, ether and acetic acid are compounds comparable to water, organic waters.' Hofmann and myself had already compared the compound ammonias to ammonia itself. * * * To Gerhardt belongs the merit of generalizing these ideas, of developing them, and supporting them with his beautiful discovery of anhydrous organic monobasic acids. Although he did not introduce into the science the idea of types, which belongs to Dumas, he gave it a new form, which is expressed and essentially reproduced by the proposition of Kolbe." "Gerhardt reduced all organic bodies to four types, hydrogen, hydrochloric acid, water and ammonia." (*Répertoire, etc.*, p. 355.)

The historical inaccuracies of the passage just quoted are the more surprising, since in March, 1854, I published in this Journal ([2], xvii, 194,) a concise account of the progress of these views. This paper was republished in the *Chemical Gazette* (1854, p. 181), and copies of it were by myself placed in the hands of most of the prominent chemists of England, France and Germany. In this paper I have shown that the germ of this idea of mineral types is to be found in an essay by Auguste Laurent, (*Sur les combinaisons azoteés, Ann. de Chimie et de Physique*, Nov. 1846,) where he showed that alcohol may be looked upon as water H_2O_2 in which ethyl (C_4H_5) replaces one atom of hydrogen, while hydric ether is the result of a complete substitution of the hydrogen by a second atom of ethyl. Hence he observed that while ether is neutral, alcohol is monobasic and the type of the monobasic vinic acids, as water is the type of bibasic acids. In extending and developing this idea of Laurent's I insisted in March, 1848, and again in January, 1850, upon the relations between the alcohols and water as one of homology, water being the first term in the series, and H_2 in like manner the homologue of formene and acetene, while the bases of Wurtz were said to sustain to their corresponding alcohols the same relation that ammonia does to water. (This Journal, v, 265, ix, 65.)

In a notice of his essay published in September, 1848, (Ibid, vi, 173,) I endeavored to show that Laurent's view might be farther extended so as to include in the type of water, "all those saline combinations (acids) which contain oxygen," and in a paper read before the American Association for the Advancement of Science, at Philadelphia in Sept. 1848, I farther suggested that as many neutral oxygenized compounds which do

not possess a saline character are derivatives of acids which are referrable to the type H_2O_2, "we may regard all oxygenated bodies as belonging to the type H_2O_2," which as I farther showed in the same essay is but a derivative of the primal type H_2, to which I referred all hydrocarbons and their chlorinized derivatives, as also the volatile alkaloids, which were regarded "as amidized species" of the hydrocarbons, in which the residue amidogen, NH_2, replaced an atom of H or Cl, or what is equivalent, the residue NH took the place of O_2 in the corresponding alcohols. (Ibid., viii, 92.)

In the paper published in Sept. 1848, I showed that while water is bibasic, the acids which like hypochlorous and nitric acids are derived from it by a substitution of Cl and NO_4 for H, are necessarily monobasic, and I then pointed out the possible existence of the nitric anhydrid $(NO_4)_2O_2$, the result of a complete substitution, which was soon after discovered by Deville. Gerhardt at this time denied the existence of anhydrids of monobasic acids; he regarded anhydrids as characteristic of polybasic acids, and indeed was only lead to adopt my views by the discovery of the very anhydrids whose formation I had foreseen.*

In explaining the origin of bibasic acids I described them as produced by the replacement in a second equivalent of water of an atom of hydrogen by a monobasic saline group; thus sulphuric acid would be $(S_2HO_6.H)O_2$. Tribasic acids in like manner were regarded as derived from a third equivalent of water in which a bibasic residue replaces an atom of hydrogen. The idea of polymeric types was still farther illustrated in the same paper where three hydrogen types were proposed, (HH), (H_2H_2) and (H_3H_3), corresponding to the chlorids MCl, MCl_2, and MCl_3. (This Journal, vi, 174.)

I also showed that hydrogen is to be looked upon as the fundamental type, from which the water type is derived by the replacement of an atom of hydrogen by the residue HO_2; thus $(HO_2.H)$, (Ibid, viii, 93). In the same way I regarded ammonia as water in which the residue NH replaced O_2.

I farther pointed out that sulphur in its ordinary state was to be regarded as a triple molecule, S_3 (or S_6=4 volumes), and referred sulphurous acid, SO_2 (S_2O_4), to this type to which also belongs selenic oxyd. At the same time I suggested that the odorant form of oxygen, ozone might be O_3. Wurtz has since adopted sulphur vapor at 400° C. or S_6 as the type of the triple

* The anhydrids of the monobasic acids correspond to two equivalents of the acid minus one equivalent of water, as $2(NHO_3) - H_2O_2 = N_2O_{10}$, while those of the bibasic acids are formed from one equivalent of the acid by a similar elimination of an equivalent of water, thus $C_2H_2O_6 - H_2O_2 = C_2O_4$. Hence both classes of anhydrids are to be referred to the type of one molecule of water, H_2O_2.

molecule.—(*Ann. de Chim. et de Phys.*, xliv, 310.) In the same paper I suggested that gaseous nitrogen was to be regarded as an anhydrid amid, or nitryl, which may be derived from nitrite of ammonia as nitrous oxyd is from the nitrate, thus (NO_3. NH_4O)$-4HO=NN$.*—(This Journal, v, 408, vi, 172.) A late writer attributes this view to Gerhardt, who adopted it from me.

I have always protested against the view which regards the so-called rational formulas as expressing in any way the real structure of the bodies thus represented. These formulas are invented to explain a certain class of reactions, and we may construct from other points of view other rational formulas which are equally admissible.

As I have elsewhere said "the various hypotheses of copulates and radicals are based on the notion of dualism, which has no other foundation than the observed order of generation, and can have no place in the theory of the science." All chemical changes are reducible to union (identification,) and division (differentiation). When in these changes only one species is concerned, we designate the process as metamorphosis, which may be by condensation or by expansion (homogeneous differentiation). In metagenesis on the contrary unlike species may unite, and by a subsequent heterogeneous differentiation give rise to new species, constituting what is called double decomposition, the results of which, differently interpreted, have given origin to the hypothesis of radicals and the notion of substitution by residues to express the relations between the parent species and their progeny. The chemical history of bodies is a record of their changes; it is in fact their genealogy, and in making use of typical formulas to indicate the derivation of chemical species we should endeavor to show their ordinary modes of generation. (See *On the theory of chemical changes*, this Journal, xv, 226; *L. E. & D. Phil. Mag.*, [4], v, 526, and *Chem. Centralblatt*, 1853, p. 849, also *Thoughts on solution*, this Journal, xix, 100, and *Chem. Gazette*, 1855, p. 92.)

Keeping this principle in mind, let us now examine the theory of the formation of acids. As we have just seen, I taught in 1848 that the monobasic, bibasic and tribasic acids are derived respectively from one, two and three molecules of water, H_2O_2. Mr. Wurtz in 1855 put forth a similar view. He supposes a monatomic radical PO_4', a diatomic radical PO_3'', and a triatomic radical PO_2''' replacing respectively one, two and three atoms of hydrogen in H_2O_2, H_4O_4, and H_6O_6; thus $(PO_4'H)O_2$ $(PO_3''H_2)O_4$, and $(PO_2'''H_3)O_6$. These radicals evidently correspond to PO_5 which has lost one, two and three atoms of ox-

* May not nitrogen, as we have elsewhere suggested, under certain conditions regenerate ammonia and a nitrite, and may not this reaction enter into certain processes of nitrification? I propose at an early day to consider this question.

ygen in reacting upon the hydrogen of the water type, and the acids may be accordingly represented as found by the substitution of the residue PO_5-O, for H, etc.

To this manner of representing the generation of polybasic acids we object that it encumbers the science with numerous hypothetical radicals,* and moreover fails to show the actual successive generation of the series of acids in question. When phosphoric anhydrid $P_2O_{10}=(PO_4)_2O_2$ is placed in contact with water it combines with one equivalent, H_2O_2. The union is followed by homogeneous differentiation, and two equivalents of metaphosphoric acid result; $(PO_4)_2O_2+H_2O_2=2(PO_4H)O_2$. Two equivalents of this acid in contact with one of water at common temperatures are slowly transformed into two of pyrophosphoric acid, by a reaction precisely similar to the last; $2(PHO_6)=(PHO_5)_2O_2+H_2O_2=2(PHO_5.H)O_2$; and two equivalents of pyrophosphoric acid when heated with a third equivalent of water yield in like manner two of tribasic phosphoric acid; $2(PH_2O_7)=(PH_2O_6)_2O_2+H_2O_2=2(PH_2O_6.H)O_2=2PH_3O_8$.

The above, which we conceive to be a simple statement of the process as it takes place in nature, dispenses alike with hypothetical radicals and residues, both of which are however convenient for the purposes of notation. In the selection of a typical form to which a great number of compounds may be referred, hydrogen or water, from its simplicity, as already remarked by Wurtz, and also from the important part which it plays in the generation of species, merits the preference. Water and carbonic acid are both so directly concerned in the generation of the bodies of the carbon series, that either may be assumed as the type, but we prefer to regard C_2O_4 like all the other anhydrids as a derivative of water and eventually of the hydrogen type.

These views were first put forward by myself in 1848, when I expressed the opinion that they were "destined to form the basis of a true natural system of chemical classification," and it was only after having for four years opposed them to those of Gerhardt, that this chemist in June, 1852, renounced his former views, and without any acknowledgment, adopted my own (*Ann. de Chimie et de Physique* [3], xxxvii, 285). Already in 1851, Williamson in a paper read before the British Association developed the ideas relative to the water type to which Wurtz refers above, and to Williamson the English editor of Gmelin's

* Those who are familiar with chemical literature will remember an amusing *jeu d'esprit* of the lamented Laurent in which he invited the attention of the advocates of the radical theory to a new electro-negative radical which he named Eurhizene, (*Comptes Rendus des Travaux de Chemie*, 1850, pp. 251 and 376). It was not without a smile that we observed a late writer in *The Chemical News*, vol. i, 326, proposing as a newly invented radical under the name of hydrine, the peroxyd of hydrogen HO_2, the eurhizene of Laurent!

Handbook, ascribes the theory. The notion of condensed types, and of hydrogen as the primal type, was not so far as I am aware brought forward by either of these, and remained unnoticed until resuscitated by Wurtz in 1855, seven years after I had first announced it, and one year after my reclamation published in this Journal in March, 1854.

My claims have not however been overlooked by Dr. Wolcott Gibbs; in an essay on the polyacid bases, he remarks that in a previous paper he had attributed the theory of water types to Williamson and Gerhardt, and adds "in this I find I have not done justice to Mr. T. Sterry Hunt, to whom is exclusively due the credit of having first applied the theory to the so-called oxygen acids and to the anhydrids, and in whose earlier papers may be found the germs of most of the ideas on classification usually attributed to Gerhardt and his school." (Proc. Amer. Assoc. for the Advancement of Science, Baltimore, May, 1858, p. 197.)

It will be seen from what precedes that I not only applied the theory, as Dr. Gibbs says, but except so far as Laurent's suggestion goes, invented it and published it in all its details some years before it was accepted by a single chemist.

In conclusion I have only to ask that future historians will do justice to the memory of Auguste Laurent, and will ascribe to whom it is due the merit of having given to the science a theory which has exercised such an important influence on modern chemical speculation and research, remembering that my own publications on the subject, which cover the whole ground, were some years earlier than those of Williamson, Gerhardt, Wurtz or Kolbe.

Montreal, Canada, Jan. 5, 1861.

Note to Mr. Hunt's paper on Types.—Gerhardt long since maintained that we can not distinguish between polybasic salts and what are called subsalts, which are as truly neutral salts of a particular type. Thus the bibasic and tribasic phosphates are to be looked upon as subsalts which sustain the same relation to the monobasic phosphates that the basic nitrates bear to the neutral nitrates. He succeeded in preparing two crystalline subnitrates of lead and copper, having the formulas $NO_5.M_2O_2.HO$ (tribasic), and $NO_5.M_4O_4.H_3O_3$ (quadri or septabasic), both of which retain their water of composition at 392° F. The compounds of sulphuric acid are, 1st, the true monobasic sulphate, $S_2O_6.MO$, corresponding to the Nordhausen acid and to the anhydrous bisulphates. 2d, the ordinary neutral sulphate, $S_2O_6.M_2O_2$. 3d, the so-called disulphates, $S_2O_6.M_4O_4$, corresponding to the crystallized or glacial acid, density 1·780; 4th, the sulphates, $S_2O_6.M_6O_6$, represented by turpeth mineral; and, 5th, the so-called quadribasic sulphate, $S_2O_6.M_8O_8$. The copper salt of this type, according to Gerhardt, retains moreover 6HO at 392° F. Without counting the still more basic sulphates of zinc and

copper described by Kane and Schindler, we have a monobasic sulphate, *a*, S_2HO_7; a bibasic, *b*, $S_2H_2O_8$; a quadribasic, *c*, $S_2H_4O_{10}$; a sexbasic, *d*, $S_2H_6O_{12}$; and an octobasic, *e*, $S_2H_8O_{14}$. (*Gerhardt on Salts, Jour. de Pharmacie*, 1848, vol. xii. and this Jour., vi, 336.) These salts, in accordance with Wurtz's notation, correspond to the following radicals: *a*, S_2O_5, monatomic; *b*, S_2O_4, diatomic; *c*, S_2O_2, quadri-tetratomic; *d*, S_2, hexatomic; and *e*, S_2-O_{10}, octo-atomic. It is easy to apply a similar *reductio ad absurdum* to the radical theory in the case of the oxychlorids and other basic salts and to show that the radicals of the dualists are often merely algebraical expressions. (See farther my remarks, this Journal, vii, pp. 102–104.)

ART. XXV.—*Description of three new Meteorites.—Lincoln County Meteoric stone which fell in August*, 1855—*Oldham County* (*Ky.*) *Meteoric Iron—Robertson County* (*Tenn.*) *Meteoric Iron;* by J. LAWRENCE SMITH, M.D., Prof. Chem. Med. University of Louisville.

LINCOLN COUNTY METEORITE.—This meteorite was examined several years ago having been sent to me for that purpose by Prof. J. M. Safford, State Geologist of Tennessee; the result of my examination was embodied in Prof. Safford's report of the geology of Tennessee for 1855, but has never received a special notice in any scientific journal, and as it is not too late to make up that deficiency, the following is sent for publication, embracing Prof. Safford's account of its fall with the chemical examination. The following particulars in regard to its fall were furnished by the Rev. T. C. Blake of Cumberland University.

"It fell two miles west of Petersburg, and fifteen northwest of Fayetteville, in Lincoln county, about half-past three o'clock, P. M., August 5th, 1855, during, or just before, a severe rainstorm. Its fall was preceded by a loud report, resembling that of a large cannon, followed by four or five lesser reports; these were heard by many persons in the surrounding country. Immediately after, this mass or fragment was seen by James B. Dooley, Esq., to fall to the ground. It approached him from the east, appeared, while falling, to be surrounded by a "milky" halo, two feet in diameter, and fell one hundred and fifty or two hundred yards from him, burying itself about eighteen inches in the soil. When first dug out, it was too hot to be handled.

This specimen has an edge broken off, revealing the character of the interior. Within it is of an ashen-gray color, varied by patches of white, yellowish and dark minerals.

With the exception of the broken edge, it is covered, and when first obtained was entirely covered, as most meteorites of

this kind are, with a very 'black, shining crust, as if it had been coated with pitch.'

One end or face, which may be regarded as the base, has an irregular rhomboidal outline, averaging $2\frac{3}{4}$ by $2\frac{1}{2}$ inches. Placing the stone upon this end, the body of it presents the form of an irregular, slightly oblique, rhomboidal prism. The upper end, however, is not well defined, but runs up to one side in a flattened protuberance, giving the entire specimen a form approaching roughly an oblique pyramid. The length from the base to the apex is $4\frac{1}{2}$ inches.

Three adjacent sides are rough, being covered with cavities and pits. The other sides are smoother and rounded.

The specimen acts upon the needle; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire specimen is 3·20. Its weight, in its present condition, 3 lbs., $14\frac{1}{4}$ oz.

The minerals found in the meteorite are:

Pyroxene—principal portion of the mass;

Olivine and orthoclase—disseminated through the mass;

Nickeliferous iron—forming about one half per cent of the mass.

In addition to these, there are specks of a black, shining mineral, not yet examined."

The general analysis is as follows:

Silica	49·21
Alumina	11·05
Protoxyd of iron	20·41
Lime	9·01
Magnesia	8·13
Manganese	.04
Iron	·50
Nickel	minute quantity.
Phosphorus	" "
Sulphur	·06
Soda	·82
	99·23

The minute quantity of nickel that was separated did not permit of my examining for cobalt, but there is no doubt that this metal was present.

OLDHAM COUNTY METEORITE.—The announcement of the discovery of this iron meteorite with the one that follows was made in a note in the last number of this Journal.

It was discovered in the month of October 1860, by Mr. Wm. Daring near Lagrange, in Oldham County, Ky. There is nothing known with reference to the time of its fall. It came into my possession shortly after its discovery.

It was entire and weighed *one hundred and twelve pounds.* Its extreme dimensions were, length twenty, breadth ten and three-

fourths, and thickness six and a half inches; its shape was elongated and flattened. Its specific weight is 7·89 and an analysis furnished

Iron	91·21
Nickel	7·81
Cobalt	·25
Copper	minute quantity not estimated.
Phosphorus	·05
	99·32

Robertson County Meteorite.—This mass of meteoric iron came into my possession during the month of December, 1860, being sent by Prof. Lindsley of Nashville, Tenn. It was discovered by Mr. D. Crockett, near Coopertown, in Robertson county, Tenn. The time of its fall is not known.

Its weight was *thirty-seven pounds*, its form was wedge-shaped, and its extreme dimensions, length ten, breadth nine and a half, thickness five and a half inches. Its specific gravity is 7·85. On cutting through the mass, a module of sulphuret of iron was discovered about $\frac{1}{4}$th inch in diameter, and there are doubtless others in its interior. The iron on analysis furnished

Iron	89·59
Nickel	9 12
Cobalt	·35
Copper	minute quantity not estimated.
Phosphorus	·04
	99·10

Louisville, January 29, 1861.

Art. XXVI.—*Correspondence of Mr. Jerome Nicklès, dated Nancy, December 5th*, 1860.

Obituary.—Since my last communication, France has lost three savans, one of whom was one of the oldest members of the Institute, and another one of the youngest. Of these two, the first is M. Duméril the zoologist, the second the botanist, Payer. The third is the hydrographer, M. Daussy, who many years since became unknown to science, and who is therefore least known of the three. He died the same day as M. Payer, viz., the 5th of September.

Duméril.—Duméril, who died the 14th of Aug., 1860, aged 87 years, was born at Amiens, Jan. 1st, 1774. He had a taste for natural history and a peculiar ability for teaching it, which he exercised without cessation whether at the School of Science at Paris, where he taught zoology, or at the School of Medicine, where he was Professor of anatomy, or at the Museum where he taught herpetology, a speciality which he pursued with great success. His first publications, having for their object the natural classification of insects, bear the date of 1797. In 1800, he compiled, under the direction of Cuvier, the first two volumes of *Leçons Anatomie Comparée* of that great naturalist, who was pleased to acknowledge that he had not only aided him by his pen, but that he was in-

debted to him for many curious observations, among which was the analogy of structure existing between the vertebræ and the bones of the cranium. He may be considered as one of the founders of those anatomical theories which four years later exercised a powerful influence upon the direction of the studies of naturalists.

About the same time Duméril succeeded Cuvier as professor at the central school of the Pantheon, where he had for his colleague, Alexander Brongniart. In 1802, Lacépide entrusted to him, the course on herpetology and ichthyology at the Museum. He filled this appointment for 55 years; during this period he formed, at the Museum, the most beautiful collection of herpetology which exists, as well as a menagerie for reptiles, the first which had been undertaken. About this time he also published in connection with M. Bibron his valuable work on general herpetology.

Afterwards he was engaged upon his *Icthyologie Analytique;* he was then 80 years of age: still later he wrote his *Entomologie Analytique*, in two volumes. When he presented this work to the Academy of Sciences he was 87 years of age.

Like Duvernoy, his rival and fellow disciple,* he devoted as much as half of his time to the practice of medicine and in 1805 he is seen in Spain confronting the dangers of a malignant epidemic in order to contribute to the progress of his art: thus he never overlooked the practice of medicine, although as has been stated, he taught comparative anatomy. He occupied successively several different chairs in the faculty of Medicine at Paris.

M. Payer.—Jean Baptiste Payer, died September 5th, 1860. Born February 3d, 1818, at Asfeld, (in the Department of Ardennes,) he was at an early age distinguished for the splendor of his oratory. He entered upon the study of law and the sciences and was made doctor in 1840. In the same year he was appointed Professor of mineralogy and geology at the Faculty of Science of Rennes. He did not long retain this position which diverted him from his favorite pursuit of botany. He returned to Paris the following year to teach Botany at the Normal School, and to supply the place of M. de Mirbel at the Faculty of Sciences.

Although constantly occupied as incumbent of the chair of botany he fitted himself to receive the degree of Doctor of Medicine and Pharmacy in 1843, at the school of Pharmacy at Strasbourg. There are two other schools of Pharmacy in France, viz., at Paris and Montpellier, but that at Strasbourg is the most important in relation to the studies which are pursued there, and the care with which the students are exercised in the pursuits of chemistry and natural history. Payer passed there, the following year, his fourth examination, as did the chemist, Gerhardt, the next subsequent year, and sustained with great honor a thesis upon the natural system of botany.

In 1848, after the revolution of February, he was appointed Minister of Foreign Affairs, by M. de Lamartine, chief of the cabinet, and he was also a representative of the people in the Constituent Assembly, where he belonged to the democratic party. Despite these distractions, he did not lose sight of his plans for the future, for they were realized in 1852,

* See this Journal, [2,] vol. xx, p. 105.

when he was named for the chair of vegetable organography at the Faculty of Sciences of Paris, in place of Auguste de Saint-Hilaire.

This chair was soon united with that of Vegetable Anatomy and Physiology, which became vacant by the death of Adrian de Jussieu. It was about this time that Payer published his principal works on Natural History.

We are indebted to him for memoirs upon various questions in vegetable anatomy and physiology, but his most important labors were related to a new science called by M. de Mirbel, *Organogeny*. He developed the latter in a great work, entitled "*Traite d'Organogenie Végétale Comparée*." He also published "*Botanique Cryptogamique ou Histoire des Familles Inférieures*." He edited D'Adanson's "*Le Cours Elémentaire d'Histoire Naturelle*," to which is added an introduction and notes on the natural families of plants by the same author. His treatise on organogeny made him the leader of a new school in which relation he is reproached for want of respect for his seniors: we have had occasion before to speak of this subject in this Journal, in 1857.

The death of Payer surprised every one, his friends not excepted, for they were unacquainted with his disease; he succumbed to the results of a surgical operation for a fistula; we shall presently allude to this again.

Pierre Daussy.—M. Daussy also succumbed to a surgical operation, which is usually devoid of danger, viz., lithotrity. Born at Paris in 1792, Pierre Daussy was admitted in 1806 to the corps of hydrographic engineers. After having, for fifteen years, taken part in the survey of the coast of France, he was nominated in 1829 as chief engineer of the French marine.

His memoir upon the perturbation of planets was in 1813, honored by the Academie des Sciences. Besides various articles furnished to the *Connaissance des Temps*, we are also indebted to him for a report upon the arc of the meridian between Dunkirk and the island of Formentara,* also for *Des Tables des Positions des Principaux Lieux du Globe*, 1847, *in* 4°, and a great number of other papers of much value.

Insalubrity of the air of Paris.—The operation, by no means severe, which cost M. Payer his life, has called attention to questions relating to the air of great cities. Dr. Castelnau reported in the *Moniteur des Sciences Médicales et Pharmaceutiques* that it had long been known to the surgeons of Paris, that surgical wounds do not unite as well in Paris as in the country. This may explain the numerous failures of Velpeau, chief surgeon of the Hospital La Charité. M. Castelnau declares that there is less danger to be apprehended from the operation of an empiric, than from an operation at Paris by the best surgeon. "Since this fact," says Dr. C., "is daily verified before our eyes, it is truly surprising that such an operation as M. Payer underwent, and which requires no haste, should be performed in the heart of Paris, when it is so easy to remove the patient to a healthy locality." Surgical operations performed at Paris, are frequently followed by erysipelas of a character more or less alarming, which appears to pass from one patient to another, as though carried by the clothes of the surgeon. Despite the ability of the operator, the Cæsarian section has never been successful at Paris. Amputations of the

* *Rapport sur la determination de la longueur de l'arc du méridien entre les parallèles de Dunkerque et I. Formentara.*

thigh are almost always fatal at Paris, though they generally terminate favorably, when performed upon the field of battle.

Diffusion of Germs, (Panspermia), *Researches upon Spontaneous Generation.*—We recently gave our readers the views of this question entertained by Pouchet;* many scientific men have pronounced against the conclusions of this zoologist, and have referred the origin of the vegetable mycoderms obtained by him, where the atmospheric air was excluded, to microscopic germs floating in the air, and which are so small that they may be introduced into the apparatus, despite the precautions taken to exclude them. According to this theory it is necessary to suppose that the air is full of these germs, therefore Pouchet has undertaken to submit the atmospheric air to microscopic examination. He has not found either germs or spores of infusoria in the dust suspended in the air, but he has found a great number of grains of starch. The air of great cities and other inhabited places, contains many of these starch grains, which, according to him, one might take to be eggs of infusoria, or germs of mycoderms. He has found them among the dust of old cathedrals, and even in dust obtained from Egyptian mummies, and the chambers of the pyramids, as well as among the ruins of Grecian temples. Yet there must be something in the air which has escaped recognition by the microscope, for by causing a quantity of air to pass through a tube containing calcined asbestos, and introducing some of this material into liquids which previously had access only to calcined air, and which consequently contained no trace of vegetation, Pasteur has been able to develop mucedines. We have seen the apparatus of this chemist in use at the *École Normale de Paris.* This apparatus is remarkable for its simplicity and its precision, and it is impossible to object to his conclusions, for they preclude the possibility on the part of nature to continue her creative work in connection with elements purely mineral, or to animate them with the organic influence.

This chemist has already informed us,† that, in order that vegetation may be developed, or fermentation produced, there is required a liquid containing water, a salt having ammonia as a base, a carbonaceous substance, and a phosphate; the air is necessary only for the moment while we introduce into the flask, some spores of *penicilium*, or a little dust obtained from the air by the process indicated above. The mycodermic vegetation is then developed in less than a day, and, what is particularly remarkable, it is developed in the dark as well as in the light. The ordinary law does not govern these little organisms, for they neither give out oxygen nor absorb free carbonic acid; but on the contrary they disengage carbonic acid, and increase by fixing ammonia and phosphoric acid. The germs which produce these marvelous effects are not uniformly distributed in the air; thus Pasteur, making comparative experiments with one and the same liquid arranged in flasks completely deprived of air, found that the air from the cellars of the Observatory, contained only one-tenth part as many germs as the air from the court of that establishment; and

* See this Journal, [2,] xxvii, p. 253, and xxix, p. 414.
† See this Journal, [2,] xxix, p. 412.

that the air contained fewer germs in proportion to its elevation in the atmosphere. This chemist has performed comparative experiments in the mountains of Jura, at an altitude of 800 metres, and in the Alps at Montanvert, (Savoy), at 2000 metres above the level of the sea; and he has proposed to take the air from a much greater elevation by the aid of a balloon.

These researches present an interesting field to the naturalist. Pasteur has many species in vegetation, new and hitherto unknown. By varying the conditions, it will doubtless be possible to obtain others, as Paul Laurent has already done with the infusoria in a work of which we shall speak further on. On the occurrence of these researches, Boussingault called attention to a fact pointed out by Bineau, of Lyons, who, while examining a specimen of rainwater, containing nitrates and ammonia in solution, found these materials disappearing under the influence of cryptogamic vegetation. In reference to this great question of the assimilation of nitrogen, we would refer the reader, who wishes to understand it thoroughly, to the valuable work of Boussingault, just published, entitled, "*Agronomie, Chimie Agricole et Physiologie.*"

In order that plants may be developed in meteoric waters, these waters should be found in the condition of Pasteur's liquids. It is known that rainwater contains assimilable nitrogen and also salts of potash, soda, lime, &c., but it has heretofore lacked the indispensable element, phosphoric acid, which had never been detected in rainwater. This chasm in the series of fertilizing principles of meteoric waters, has at length been filled by Barral, who has discovered phosphates in rainwater. To avoid all sources of error, this chemist has experimented entirely with an apparatus of platinum. In the residue of evaporation he has obtained the phosphorus in the condition of phosphoric acid, as phosphate of bismuth, (Chancel's process), and as the ammoniaco-magnesian phosphate. He has thus found a quantity of phosphoric acid, varying from ·05 to ·09 of a milligram to a litre of rainwater (=0·000·5 to 0·000·9 gram).

From these results it may be calculated that the rainwater of an ordinary shower furnishes about 400 grams of phosphoric acid to the French *hectare* (or 2½ English acres). Now since the researches of Boussingault have proved that a hectolitre, (2¾ bushels), of wheat takes from the soil about one kilogram of phosphoric acid, we see that to obtain seven or eight hectolitres of wheat to the French *hectare*, which corresponds to a harvest without the use of manure, it would be necessary to let the field repose for twenty years, if the soil did not previously contain a trace of phosphates. Barral in 1850 to 1852, made researches upon rainwater to detect the presence of phosphoric acid in the residue of evaporation; the udometres and other vessels of platinum employed in the present investigations were constructed at the expense of the Académie des Sciences.

Chemical Synthesis.—The most remarkable scientific event of modern times, is the publication of a treatise on chemistry, proceeding on the same plan in organic chemistry, as has been adopted for a century past, in mineral chemistry, that is, forming organic substances *synthetically* by combining their elements by the aid of chemical forces only. The author who has performed his demonstrations by this method, is Berthelot, who has been occupied with organic synthesis since he first devoted himself to

chemistry. Berthelot is not a *vitalist*, (see our last contribution);* he is convinced that, "we may undertake to form *de novo*, all the substances which have been developed from the origin of things, and to form them under the same conditions, by virtue of the same laws and by means of the same forces which nature employs for their formation." Let us hasten to add a distinction upon which Berthelot properly insists and which it is necessary to recognize, between organs and the matter of which they are composed. "No chemist pretends to form in his laboratory, a leaf, a flower, a fruit or a muscle, these questions relate to physiology," and it was by not observing this distinction that it was possible to form that school of medicine of which mention was made in my last communication—and which referred everything to vital force. (See *Journal de Chimie et de Pharmacie*, Sept., 1860). This distinction being admitted and calling to mind the syntheses recently effected, such as the direct preparation of C^4H^4 from carbon and hydrogen, and alcohol from the union of C^4H^4 and water, we may understand the possibility of performing for organic chemistry what has been done for mineral chemistry, and to give to it a basis independent of the phenomena of life.

"I have taken for a point of departure, the simple bodies; carbon, hydrogen, oxygen and nitrogen, and I have constructed by combination of these elements, organic compounds, first binary then ternary, &c., the former analogous and the latter identical with the proximate principles contained in living beings themselves." Notice the progressive order of these synthetic formations. "The substances which we first prepare by methods purely chemical are the principal carbids of hydrogen, that is to say the fundamental binary compounds of organic chemistry. As a means of producing all the parts from the elements themselves, we take oxyd of carbon, that is to say a substance purely mineral, and by the concurrent influence of time and ordinary affinity, we combine this oxyd of carbon with the elements of water, (e. g., by the aid of pressure and the presence of an alkali); we thus obtain a first organic compound, known as formic acid. This acid united to a mineral base, produces a formate, then decomposing this formate by heat we compel the carbon of the oxyd of carbon and the hydrogen of the water to combine in the nascent state and produce carbid of hydrogen. Thus there is formed marsh gas, propylene, &c., &c. This is the first step of synthesis.

The hydrocarbons thus prepared become the starting point for the synthesis of alcohols; with marsh gas and oxygen we form methylic alcohol, with olefiant gas and water—ordinary alcohol, &c.

The synthetic production of carbids of hydrogen and of alcohols constitutes the true difficulty, but we know that even in this, Berthelot has triumphed.† The alcohols once obtained, it is easy to obtain the greater part of the other organic compounds by the ordinary chemical forces. This chemist has thus established the fact that organic chemistry reposes upon the same basis as mineral chemistry.

What has been said of the alcohols may also be said of various other classes of organic compounds, and among others of that new group, which Berthelot calls the *Phenols*, and to which he has devoted a very interest-

* This Journal, [2,] xxx, p. 412.

† See this Journal, [2,] xx, p. 111 and p. 265.

ing chapter. *Phenol*, or *carbolic acid*, $C^{12}H^6O^2$, the type of this group, may also be obtained by direct synthesis.

Starting from benzine, $C^{12}H^6$, it is transformed by nitric acid into $C^{12}H^5NO^4$ (nitro-benzine), which under the influence of nascent hydrogen, (the Zinin process) becomes $C^{12}H^7N$, (aniline), and this under the influence of nitrous acid is changed into phenol, $C^{12}H^6O^2$, as was shown by T. S. Hunt, in this Journal, [2,] viii, p. 372.

In Synthesis, or the forces of nature, substituted for hypothesis, we see the basis of the truly original work, now under notice. Berthelot is the youngest, but also the most distinguished of our chemists.* He owes his success to the cause which gave power to Laurent, Gerhardt and other savans of the first order, to the guiding power of a fundamental idea, which in the case of Gerhardt, was, *Series*, but in the case of Berthelot, is *Synthesis*. He is only 34 years of age, and yet his work, "*La Chemie Organique, fondée sur la Synthese*" gives promise to its author of a glorious future, and to science great progress and brilliant discoveries.

Acclimation.—We have before mentioned a project conceived by the Society for Zoölogical Acclimation, (*Societé Zoölogique d'Acclimatation*)† of forming a model garden for conducting the acclimation of useful plants or animals, and for cultivating an interest in this kind of enterprise. This garden was opened the 6th of October last, and immediately made available to the public; considerable sums of money have been subscribed to make it both a useful establishment and a work of art. Fifteen months have been sufficient for this purpose. The Garden is established in the forest of Boulogne; besides the necessary buildings for offices, it includes large stables, many and elegant rustic pavillions, designed for different species of animals, an immense aviary, a large enclosure for fowls, an elegant nursery for silkworms, an aquarium of unusual extent, greenhouses, and a winter garden not yet entirely completed. The other buildings are completed and already filled. A large stream, drawn from the Seine flows through the garden and forms a beautiful ornament; it is occupied by a great number of aquatic birds.

The collection of the Zoological Garden of Acclimation, (*Jardin Zoologique d'Acclimatation*), is composed of, 1st, species and races which they have tried to acclimate in France; 2nd, species and races which have been acclimated in other countries, or which are habitually reared either for use or pleasure. Already the Société Zoologique d'Acclimatation extends throughout the entire world. We have recently mentioned the successful efforts of this society to introduce the dromedary into the desert plains of Brazil.

The Arch-Duke of Austria has sought instruction for making experiments of acclimation in the Isle of Crôma: also an Italian silk culturer favored by the relations of this Society, has succeeded in penetrating the silk districts of China, and has spent nearly two months near the city of Ouchau-fu, and has learned many of the processes employed in that country in the culture of the silk worm. It being impossible to reproduce here the interesting report which Castellani has addressed to the Society we refer the reader to the *Bulletin de la Société Zoologique*

* Biographisch-litterarisches Handworterbuch, par Poggendorff, 1858.

† See this Journal, [2], xxviii, p. 431.

d'Acclimatation, where he will find, besides this memoir, other reports, as that of Guérin Mannaville concerning the important subject of silk and the insects which produce it.

During the sojourn of Castellani in China he learned the important fact that in that country no species of silkworm is reared in the open air; for those worms which are not devoured by birds soon perish if they do not receive that intelligent care which the Chinese from time immemorial have learned to give them. The contrary has been long maintained, and it was upon a belief of such reports that they endeavored in France to rear the Bombyx Cynthia in the open air. The Bulletin de la Société d'Acclimatation contains many notices of almost complete success of experiments undertaken in the early part of the year 1859. The Bombyx Cynthia feeds upon the leaf of the *Aylanthus glandulosa.*

The Serimetre.—We cannot leave the subject of silk without mentioning the interesting machine invented by Froment for the purpose of determining *the relative tenacity and elasticity of different kinds of silk.* This instrument measures at once, 1st. The tenacity of a thread by the weight necessary to break it. 2d. The elasticity, by the elongation it sustains before breaking.

We cannot here describe this instrument, but we may give an idea of the precision of its action by stating that it enables us to determine the tenacity and elasticity of a spider's web.

These researches have led to very curious results, of which the following possess the most general interest.

1. The climate, food, and general care have a considerable influence upon the tenacity of silk, for example, the cocoons raised in Avignon gave a tenacity of 12, while cocoons of the same species raised at Paris gave only 8.

2d. It appears that the male cocoons furnish silk finer and more tenacious than that of the female cocoons. Thus for an equal length the weight of the male cocoons being represented by - - - 11·28
That of the female cocoons was - - - - - 11·59
Again a mean of 200 experiments gave for male cocoons a tenacity of - - - - - - - - - 10·63
For female cocoons the tenacity was - - - - 9·80

By reason of the small difference between these numbers the results are for the present offered with some degree of doubt, but the Société d'Acclimatation has taken measures for removing these doubts. The *Serico-metric* experiments, which we have mentioned, were made under the direction of Persoz, from whose report we have taken them.

Pseudomorphism and Pseudomorphosis.—Metamorphism, considered in the most general manner, comprehends all the modifications experienced by mineral substances; the subject may be divided according as it relates to minerals or to rocks. The first—the metamorphism of minerals—has been made, by A. Delesse the subject of profound study, which he has distinguished by the name of *pseudomorphism.* When a mineral is presented under a form which does not properly belong to it there is said to be pseudomorphism. The substance to which a mineral imparts its form may vary; it may even be of an organic nature, for a

mineralogist sees a case of pseudomorphism even in a bone, phosphate of lime is not there found in its usual form.* Delesse makes a distinction between the original or substance *pseudomorphosed*, and the *pseudomorphic* or mineral substance which replaced the first.

He also distinguishes between *pseudomorphism by alteration* and *pseudomorphism by displacement;* in the former the pseudomorphic mineral contains the elements of the first substance; in the latter the first substance has completely disappeared. For example, iron pyrites which changes into hydrous oxyd, preserving its form becomes pseudomorphic *by alteration*, while fluor spar which is replaced by quartz, is pseudomorphic *by displacement.*

Delesse arranges among pseudomorphs, the forms by *envelopment*, so well described in Prof. Dana's Mineralogy; also those phenomena which Naumann has called *zoomorphosis* and *photomorphosis*, produced when organic matter is replaced by a mineral substance† or by other matter in a different condition.

Thus vivianite is sometimes developed in the interior of bones, in the shell of mollusks and in vegetables. Prof. Dana has seen it completely replace the calcareous beak of belemnites, and I myself have seen it developed in human bones buried in ferruginous soil; a part of this phosphate had even crystallized in the form of vivianite (see this Journal, [2], xxi, p. 402), even coal sometimes pseudomorphs certain fishes into cupriferous and bituminous slates (as those of Mansfeld.)

The simple bodies are rarely pseudomorphic; they are more frequently pseudomorphosed; for the most part there is no relation between the composition and form of pseudomorphosed bodies and pseudomorphic bodies, so also the composition of bodies appears to be without influence upon forms by envelopment.

Pseudomorphism by alteration is more frequent than pseudomorphism by displacement, inasmuch as the mineral newly formed more frequently depends upon the more ancient. The same mineral may be pseudomorphic or pseudomorphosed, without the existence of any rule in this respect, this condition is often presented by such minerals as quartz, carbonate of lime and pyrites as they occur in nature. Delesse has found among 105 pseudomorphic minerals and 119 pseudomorphosed minerals, or 224 in all, only 60 minerals that are both pseudomorphosed and pseu-

* Grasses and lichens belong to this class; the first owe their structure to silica, the others to oxalate of lime. A parallel generalization is evidently an exaggeration; these organic forms have been produced under the influence of life, and according to an invariable type, very unlike those pseudomorphs or forms obtained by epigenesis.

† To us the Saurian does not appear more different from a bird than the paramorphic bodies arranged in this category of Delesse. Laurent is the author of paramorphism, who defined it as follows: "I place in this class those bodies which have a different composition and which are isomorphic but in different systems," thus octohedric AsO_3 is paramorphic with prismatic SbO_3, and prismatic AsO_3 is paramorphic with octohedric SbO_3, &c.—(*Laurent, Méthode de Chemie*, 1854, p. 172.)

It is much to be regretted that Delesse was not acquainted with the researches of Prof. Cooke on allomerism (see this Journal [2], xxx, p. 194, and *Journal de Chemie et Pharmacie*, t. xxxviii, p. 383). The ideas of Prof. Cooke explain very well the difficulties met with by Delesse and other mineralogists. J. S.

domorphic. Now admitting that the total number of minerals known is 642, the proportion of minerals in which pseudomorphism is found reaches one-fourth this number.

In this connection we may remark that these minerals are found for the most part in the metalliferous rocks.

The question of Inundations.—This important question, which has always been studied in France, has made considerable progress—a new cause of inundations has been discovered. The author of this discovery is an engineer, M. Gueymard of Grenoble, who has studied the Alps for nearly 50 years. In his opinion this cause is the absence of grass upon the sides of mountains. It existed at the commencement of this century but it has been destroyed by the great numbers of sheep pastured upon the mountains. Where grass was found fifty years ago the slopes are now denuded, and incapable of retaining the waters which have fallen in rain. Wherever there is a surface of sod 10 centimetres thick, for example, containing 10 per cent of water, it will absorb a layer of water 4·75 centimetres deep. Gueymard has concluded that the inundation which on the 30th of May, 1856, overflowed the valley of the Isère would have caused no damage if the slopes of the mountains had presented to the torrent of rain a covering of grass 20 centimetres in thickness, the earth would then have absorbed a layer of water 9·5 centimetres deep and the evil would have been averted.

The principal remedy for inundations is therefore to be found in *turfing*. Gueymard estimates ten years as the time necessary to produce upon the flanes of mountains a sod of sufficient consistence to resist effectually long continued rains.

He does not believe that destroying the forests upon mountains is the principal cause of inundations. He bases his opinion upon the fact that although there were no inundations in France from 1793 to 1840, the period during which the forests destroyed during the Revolution and restocked at the commencement of this century had not attained their full growth, yet the disasters of 1840 commenced when the forests had attained their full strength. But from 1800 to 1840, the flocks of sheep were increased three-fold, and in proportion as the trees increased in size the grass disappeared under the teeth of the animals, and with it the most efficient protection against inundations.

The French government has taken these observations under serious consideration, and made them the subject of careful study.

Bibliography.

BOSSANGE, *Paris*, has recently published:

Zoologie du Jeune Age, par Docteur LEREBOULLET, Professor de Zoologie à la Faculté des Sciences de Strasbourg.—This is a beautiful volume in quarto with colored figures. Professor Lereboullet is one of the most distinguished Zoologists in France. A considerable part of this work is elementary and in the form of lectures.

La Chimie Organique fondée sur la Synthese, par MARCELLIN BERTHOLLET, 2 vols. in 8vo, 1860. [This work is noticed above, p. 270.]

Les Electro-animants et l'adhérence Magnetique, par J. NICKLÈS.—This is a work almost entirely new, and full of facts not before published, (see this Journal [2], xxx, p. 413).

Notions de Physique, par POUILLET, 3d edition in 12mo.—This is a very excellent elementary work for those who are commencing the study of Physics.

Das Buch der Natur, par Dr. Fdk. Schoedler, 11th edition, 2 vols. 8vo.—This is a work of the same class as the preceding but much more complete, for it embraces not only physics, but physical geography, astronomy and chemistry. The first edition appeared in 1844, and was received with such favor that it has passed through eleven editions in sixteen years.

Etudes Physiologiques sur les Animalcules des Infusoires Végétales, par Paul Laurent, Professor a l'Ecole Forestière de Nancy. 2 vols. in 4to with numerous illustrations. This work has acquired much importance from the recent discussions upon spontaneous generation. M. Laurent has given the results of 25 years of observation. The first volume is entirely devoted to infusoria, the second volume treats especially of the elementary organs of vegetables.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a Compound of Boron with Ethyl.*—Frankland and Duppa have succeeded in forming a combination of ethyl and boron by the action of zinc-ethyl upon boric ether. The reaction is represented by the equation

$$2(BO_3.3C_4H_5O)+3Zn_2(C_4H_5)_2=2B(C_4H_5)_3+6C_4H_5O,ZnO.$$

and is particularly interesting as offering a new method of forming compounds of the elements with compound radicals. When zinc-ethyl is brought in contact with tribasic boric ether the temperature rises gradually during half an hour. On submitting the liquid to distillation a colorless liquid passes over between 94° and 120°. The distillation is then to be interrupted. The remainder in the retort solidifies to a crystalline mass, which is a combination of ethylate of zinc and zinc-ethyl. The distillate after two rectifications, boils between 95° and 97°. It then corresponds to the formula $B\begin{cases}C_4H_5\\C_4H_5\\C_4H_5\end{cases}$. Borethyl is a colorless soluble liquid which has a sharp odor: its vapors strongly irritate the mucous membranes and provoke a flow of tears. Its density is 0·6961 at 23°: it boils at 95°; the density of its vapor is 3·4006. The theoretical vapor-density, calculated according to the condensation of chlorid of boron, would be 3·3824.

Borethyl is not easily decomposed by water, in which it is insoluble. The liquid itself takes fire spontaneously in contact with the air and burns with a magnificent green and smoky flame; in contact with pure oxygen it explodes. When submitted to slow oxydation it forms a colorless liquid boiling at higher temperature than borethyl, but which cannot be distilled at ordinary pressures. By distillation in vacuo, this liquid may be obtained pure, and its constitution is then expressed by the formula $B\begin{cases}C_4H_5\\C_4H_5O_2\\C_4H_5O_2\end{cases}$.

This compound dissolves immediately in water, decomposing into alcohol and a white crystalline substance which may be sublimed without alteration in a current of carbonic acid gas. It then forms magnificent

scales like those of naphthaline. Its constitution is represented by the formula $B\left\{\begin{matrix}C_4H_5\\HO_2,\\HO_2\end{matrix}\right.$ and its formation depends evidently on the substitution of two atoms of hydrogen for two atoms of ethyl in the compound $B\left\{\begin{matrix}C_4H_5\\C_4H_5O_2.\\C_4H_5O_2\end{matrix}\right.$ This substance possesses an agreeable ethereal odor, and a very intense sweet taste. When exposed to the air, it volatilizes slowly at ordinary temperatures, and is partially decomposed, always leaving a little boric acid. Its vapor possesses an intense sugary odor; it reddens litmus paper, although its other acid properties are but feeble. Water, alcohol and ether easily dissolve it; it melts at a gentle heat, and boils at a high temperature, with partial decomposition.

The authors promise an extended study of these substances as well as of the reactions of zinc-ethyl with silicic, carbonic and oxalic ethers.—*Ann. de Chimie et de Physique*, lx, 374, November, 1860. W. G.

2. *On the vapor-density of Chlorous Acid.*—The vapor-density of chlorous acid was found by Millon to be 2·646. This corresponds to a condensation from 5 volumes to 3; the calculated vapor-density is then 2·7454. According to this determination, chlorous acid forms a remarkable exception to the law now generally assumed that all substances in the state of vapor correspond to 2 volumes; it also renders it necessary to consider the atomic weight of oxygen 8, and not 16.

Schiel has therefore undertaken a new determination of the vapor-density of the acid, and finds in two experiments the numbers 2·723, and 2·603, which corresponds closely to the determination of Millon. The author proposes to control these determinations by observing the ratio of the volumes of chlorine and oxygen which are obtained from a known volume of the acid.—*Ann. der Chimie and Pharm.*, lxvi, p. 115.

W. G.

3. *New Researches on the Oxyd of Ethylene.*—Wurtz has communicated some exceedingly interesting and important results of his continued investigations of the ethylene series. These may be briefly stated as follows: 1. Oxyd of ethylene unites directly with acids and neutralizes them. When the oxyd is heated in a water-bath with concentrated chlorhydric acid, the two unite directly forming chlorhydrate of oxyd of ethylene. The oxyd unites in like manner with anhydrous or hydrous acetic acid, and gives among other products the neutral acetate. 2. In uniting with acids the oxyd of ethylene is capable of forming basic salts. Thus in the last experiment, after separating the neutral acetate by distillation, there remains a considerable quantity of a liquid boiling above 200°.

This contains three products which may be considered as basic acetates of oxyd of ethylene, and which constitute in reality the acetates of polyethylenic alcohols. The first boils at about 200°, and constitutes diethylenic acetate, which is formed in consequence of the following reaction:

$$2(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,\ 2C_4H_4O_2=(C_4H_3O_2)_2\left\{\begin{matrix}C_4H_4\\C_4H_4\\O_6.\end{matrix}\right.$$

When saponified by baryta, this acetate is resolved into acetic acid and diethylenic alcohol, $\left.\begin{matrix}(C_4H_4)_2\\H_2\end{matrix}\right\}O_6$

The second product boils toward 290°, and constitutes triethylenic acetate.

$$3(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,3C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_8.$$

Under the influence of baryta it yields acetate of baryta and tri-ethylenic alcohol, $\left.\begin{matrix}(C_4H_4)_3\\H_2\end{matrix}\right\}O_8$. Finally, the third product boils above 200°, and when distilled in vacuo is a thick colorless liquid, tetrethylenic acetate.

$$4(C_4H_4O_2)+C_8H_6O_6=C_8H_6O_6,4C_4H_4O_2=\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_{10}.$$

Baryta transforms this into acetate of baryta and tetrethylenic alcohol. This last is a thick colorless neutral liquid, soluble in water and boiling above 300°.

Oxyd of ethylene is also capable of combining with diacetic glycol to form polyethelenic acetates.

$$C_4H_4O_2+\left.\begin{matrix}C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_4=\left.\begin{matrix}C_4H_4\\C_4H_4\\(C_4H_3O_2)_2\end{matrix}\right\}O_6.$$

This reaction is comparable with that which transforms acetate of lead into basic acetate, when the neutral salt is brought into contact with an excess of oxyd of lead.

$$2(Pb_2O_2)+\left.\begin{matrix}\overset{''}{P}b\\(C_4H_3O_2)_2\end{matrix}\right\}O_2=\left.\begin{matrix}\overset{''}{P}b_3\\(C_4H_3O_2)_2\end{matrix}\right\}O_8.$$

The basic properties of oxyd of ethylene are especially shown in the action which it exerts upon saline solutions. When the oxyd is mixed with a concentrated solution of chlorid of magnesium, the liquid after some hours solidifies; magnesia is precipitated, while chlorhydrate of oxyd of ethylene is formed.

The oxyd on the contrary is displaced by potash, when this is made to act upon the chlorhydrate. Heated upon a water-bath with a solution of perchlorid of iron, the oxyd of ethylene precipitates the hydrate of the sesquioxyd: it also precipitates alumina from a solution of alum and subsulphate of copper from a solution of the sulphate. These facts exhibit clearly the basic properties of oxyd of ethylene, which is comparable with the anhydrous oxyd of zinc, or oxyd of lead, while glycol itself corresponds to the hydrates of these oxyds.

$$\left.\begin{matrix}\overset{''}{Z}n\\H_2\end{matrix}\right\}O_4,\qquad\left.\begin{matrix}\overset{''}{P}b\\H_2\end{matrix}\right\}O_4,\qquad\left.\begin{matrix}C_4H_4\\H_2\end{matrix}\right\}O_4.$$

—*Repertoire de Chimie Pure, Sept.* 1860, p. 340. W. G.

4. *Transformation of Olefiant Gas into complex Organic Acids.*—In his memoir on the glycols, Wurtz had expressed the opinion that these might

be considered as the alcohols of diatomic acids: the following facts serve to confirm this view. By oxydizing diethylenic alcohol $\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6$ he has obtained an acid isomeric with malic acid, and under the same circumstances, has transformed triethylenic alcohol $\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_8$ into a still more complex acid.

The oxydation of diethylenic alcohol is easily affected by nitric acid which acts very violently; the acid liquid crystallizes when evaporated. The liquid is to be saturated with milk of lime, when a small quantity of oxalate of lime separates. The filtrate yields a lime salt in long and brilliant needles, which has the formula $C_8H_4Ca_2O_{10}+12HO$.

The acid is most easily prepared by decomposing the silver salt with sulphydric acid gas; the solution deposits voluminous crystal after concentration. The new acid crystallizes in large rhomboidal prisms, possessing a distinct acid-taste. It is very soluble in water or alcohol; its composition is expressed by the formula $C_8H_6O_{10}+2HO$.

When distilled, it yields a thick liquid which crystallizes after some time, and which constitutes a true pyrogenic acid. When fused with hydrate of potash, hydrogen is given off, while acetic and oxalic acids are formed. Wurtz considers it probable that this acid is identical or isomeric with an acid obtained by Heintz as an accessory product in the preparation of glycolic acid, by means of monochloracetic acid and hydrate of soda.

In the oxydation of triethylenic alcohol two acids are obtained, one of which is identical with that just described; the other has the formula $C_{12}H_{10}O_{12}$. This acid does not crystallize, but after separation remains in the form of a syrupy mass.

The author remarks that in the oxydation of the polyethylenic alcohols a certain quantity of hydrogen disappears and is replaced by an equivalent quantity of oxygen. We may admit that the two acids just described are derived from two corresponding alcohols, just as glycolic acid is derived from ethylenic alcohol, by the transformation of a certain number of molecules of ethylene, C_4H_4, into glycolyl, $C_4H_2O_2$, as the following formulas show.

$\left.\begin{matrix}C_4H_4\\H_2\end{matrix}\right\}O_4$	$\left.\begin{matrix}C_4H_2O_2\\H_2\end{matrix}\right\}O_4$	$\left.\begin{matrix}C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_6$	$\left.\begin{matrix}C_4H_2O_2\\C_4H_2O_2\\H_2\end{matrix}\right\}O_6$	$\left.\begin{matrix}C_4H_4\\C_4H_4\\C_4H_4\\H_2\end{matrix}\right\}O_8$	$\left.\begin{matrix}C_4H_4O_2\\C_4H_2O_2\\C_4H_2O_2\\H_2\end{matrix}\right\}O_8$		
Glycol.	Glycolic acid.	Diethylenic alcohol.	Diglycolic acid.	Triethylenic alcohol.	Dyglycol-ethylenic acid.		

These acids possess the molecular composition and the characters of the vegetable acids; they are obtained synthetically from olefiant gas, which is successively transformed into bromide of ethylene, glycol, oxyd of ethylene, polyethylenic alcohols, and finally into diglycolic and diglycolethylenic acids.—*Rep. de Chimie, Pure, Sept.* 1860, p. 342 W. G.

5. *On the determination of Phosphoric Acid.*—The process of CHANCEL for the determination of phosphoric acid by means of the acid nitrate of bismuth, has already been described in this Journal (vol. xxx, 122). The author now gives further details which are necessary to ensure the success

of the method, especially when iron is present. In this case, the precipitated phosphate of bismuth always contains iron, unless this metal is present in the form of protoxyd. The process to be pursued in general is as follows: 1. Treat the weighed substance with an excess of concentrated nitric acid by the aid of heat, so as to transform, if necessary, metaphosphoric or pyrophosphoric acids into tribasic phosphoric acid; redissolve by a sufficient quantity of nitric acid, add water, and filter if necessary. 2. Remove the sulphuric acid from the dilute solution by nitrate of baryta, then the chlorine by nitrate of silver. 3. Pass a current of sulphuretted hydrogen to saturation through the filtered liquid. In this manner the iron is completely reduced to protoxyd, even when the liquid contains a large quantity of free nitric acid, while silver and other metals which give insoluble sulphides are completely precipitated. Before filtering, the sulphydric acid gas must be completely removed by passing a current of carbonic acid through the liquid, till the gas no longer darkens paper soaked in acetate of lead. 4. An excess of acid nitrate of bismuth is then to be added to the filtered liquid, the precipitate allowed to settle, collected on a filter, washed with boiling water, dried, ignited and weighed. 5. The bismuth may then be removed from the filtrate by means of sulphuretted hydrogen, and the bases present determined in the ordinary manner. —*Comptes Rendus*, li, 882. W. G.

[See on p. 281 an interesting note on this subject by Mr. McCurdy.]

6. *On the preparation of Oxygen.*—H. St. Clair Deville and Debray, in studying the economical production of oxygen upon the large scale, have arrived at results which promise to be of great practical importance. The authors find that sulphate of zinc when heated alone in an earthen or porcelain vessel yields a light and white oxyd which may be utilized in painting; sulphurous acid, which is easily absorbed by water; and finally pure oxygen. The temperature required is not much higher than that which is necessary for the decomposition of peroxyd of manganese.

Another and very elegant process, consists in the decomposition of sulphuric acid by heat. A fine stream of the acid is allowed to flow into a retort of about five litres capacity, filled with thin platinum foil and heated to redness. The acid is completely decomposed into oxygen, water and sulphurous acid, which last is absorbed by an appropriate washing apparatus. The sulphurous acid may again be converted into sulphuric acid, in the usual manner.—*Comptes Rendus*, li, 822. W. G.

7. *On the Polyethylenic Alcohols.*—Lourenço has studied the action of bromid of ethylene upon glycol, and has discovered several new polyethylenic alcohols closely related to those already described by Wurtz. The diethylenic, triethylenic and tetrethylenic alcohols of Wurtz are among the products of the reaction and may be separated by a fractional distillation. In addition to these, the two alcohols belonging to the same series are formed. Pentethylenic alcohol whose formula is

$$\left.\begin{matrix} C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ H_2 \end{matrix}\right\} O_{12} = C_{20}H_{22}O_{12}.$$

is a viscid liquid like glycerine, soluble in water, alcohol and ether, and boils at about 281° under a pressure of 0·025^{mm}, that is to say almost in vacuo.

Hexethylenic alcohol is only to be distinguished from the last by its greater viscidity. It boils at about 325° under the same pressure of 0·025mm. Its formula is $\left.\begin{matrix} C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ C_4H_4 \\ H_2 \end{matrix}\right\} O_{14} = C_{24}H_{26}O_{14}$.

When the operation is conducted for a sufficiently long time and an excess or glycol is employed, other alcohols of the same series are obtained, the general formula being $\left.\begin{matrix} nC_4H_4 \\ H_2 \end{matrix}\right\} O_{2n+2}$.

The compounds become more and more viscid as their molecular complication increases. We remark a difference of about 45° in their boiling points. When the mixture of bromid of ethylene and glycol is heated above 130°, very different results are obtained. The liquid becomes brown and the alcohols disappear, giving rise to the corresponding bromhydric ethers.—*Comptes Rendus*, li, p. 365. W. G.

7. *On Baudrimont's Protosulphid of Carbon.*—Playfair has examined the different processes given by Baudrimont, for the preparation of the protosulphid of carbon. These processes are not less than five in number; though the author admits that only the first yields the compound in a state of tolerable purity. This process consists in passing the vapor of bisulphid of carbon over red hot pumice stone or spongy platinum, by which, according to Baudrimont, sulphur is deposited and the gaseous protosulphid set free. Playfair found on repeating this process that no protosulphid of carbon whatever is formed, but that the gas given off consists of carbonic oxyd and nitrogen; while the greater proportion of the bisulphid of carbon passes over undecomposed. In like manner it was found that when the vapors of bisulphid of carbon were passed over red hot charcoal, only a mixture of carbonic oxyd, nitrogen and bisulphid of carbon was obtained. The author concludes that there is no sufficient evidence of the existence of protosulphid of carbon, all the processes described for its preparation, having failed to yield it.

W. G.

Analytical Chemistry.

Contributions from the Laboratory of the Yale Scientific School;—communicated by Profs. Brush *and* Johnson.

8. *Observations on Chancel's method of estimating phosphoric acid;* by Henry I. McCurdy.—The following new method for the detection and quantitative separation of phosphoric acid by means of nitrate of bismuth has been lately recommended by Chancel as of universal applicability. A nitric acid solution of the substance containing phosphoric acid is treated with a solution of nitrate of bismuth* as long as a precipitate is formed.

* Best prepared, according to Chancel's latest advice, by dissolving 68·45 gms. of the pure crystallized neutral nitrate of bismuth, $BiO_3 3NO_5 + 10aq$ in a quantity of nitric acid representing 68·5 gms. of anhydrous nitric acid and bringing the solution to the volume of a liter. Each cubic centimeter of this solution precipitates 1 centigram of phosphoric acid.

It is then boiled; filtered and the precipitated phosphate of bismuth is washed with hot water, dried, ignited and weighed. Chlorine and sulphuric acid, if present, must first be removed by means of the nitrates of baryta and silver. Too great an amount of nitric acid must be avoided, since the phosphate of bismuth though insoluble in a moderate quantity of nitric acid, is soluble in a large excess.

I have recently made some experiments on this method, at the suggestion of Prof. Johnson, which go to show that in the presence of certain sesquioxyds it is utterly valueless. I proceeded as follows: a solution of nitrate of bismuth was prepared according to Chancel's directions, and also a solution of pure phosphate of soda. These two solutions were of such strength that one cubic centimeter of the nitrate of bismuth solution contained a little more bismuth than was necessary to precipitate the whole of the phosphoric acid in 1 c. c. of the phosphate of soda solution.

A strong solution of the nitrate of the sesquioxyd of iron was then prepared, and to 1 c. c. of it were added successively 1 c. c. of the phosphate of soda solution and 1 c. c. of the nitrate of bismuth solution. No precipitate was formed even after boiling the mixture. The pernitrate of iron was diluted with nine parts by volume of water, and to 1 c. c. of this dilute solution were added equal amounts of phosphate of soda and nitrate of bismuth. A rather bulky precipitate came down, but after boiling, the filtrate on being tested with molybdate of ammonia was found to contain phosphoric acid in large quantity. The experiment was repeated, using two, three and four c. c. of the dilute solution of ferric nitrate to 1 c. c. each, of the solution of phosphate of soda and nitrate of bismuth with similar results—the precipitate of phosphate of bismuth diminishing and the amount of phosphoric acid in the filtrate increasing regularly as more and more of the iron salt was added. When 5 c. c. of the solution of iron were employed to 1 c. c. each, of the two other solutions, there was no precipitate whatever, the whole of the phosphate of bismuth being held in solution by the nitrate of iron.

In all cases where phosphate of bismuth was precipitated in presence of nitrate of sesquioxyd of iron it carried down with it a notable quantity of iron, as manifested by the color of the precipitate, which was brownish red when a large proportion of iron existed in the solution and of a yellow tint when the amount of iron was small.

A strong solution of nitrate of alumina was prepared by saturating nitric acid (of sp. gr. 1·16) with pure, freshly precipitated hydrate of alumina, and some experiments were made with this solution, using in each case, 1 c. c. of the solution of phosphate of soda and 1 c. c. of the solution of nitrate of bismuth, to successively increasing quantities of the nitrate of alumina. With 1 c. c. of the nitrate of alumina solution there was formed a considerable precipitate, but when the solution was filtered, and tested with molybdate of ammonia it was found still to contain phosphoric acid. After dissolving this precipitate in hot nitric acid and separating the bismuth by sulphuretted hydrogen, ammonia indicated the presence of phosphate of alumina, showing that the phosphate of bismuth had carried down a portion of alumina with it. With 2 c. c. of nitrate of alumina there was scarcely any precipitate on boiling, and with 3 c. c. the phosphate of bismuth was entirely prevented from separating.

Experiments were made with a solution of nitrate of sesquioxyd of chromium and it was found that 5 c. c. of chromic nitrate employed to 1 c. c. each, of the solutions of phosphate of soda and nitrate of bismuth, were sufficient to prevent the formation of any precipitate. The solution used was a rather strong one.

Nitrate of sesquioxyd of uranium even in small quantities prevents the complete precipitation of phosphoric acid by this method, and when in large amount, dissolves the precipitate entirely. The phosphate of bismuth when thrown down from a solution containing uranic nitrate is contaminated with the latter.

A similar series of experiments was made with the nitrates of ammonia, potassa, baryta, strontia, lime, and magnesia. The presence of these bases does not seem to interfere with the success of the method.

It follows from these trials that the method proposed by Chancel, can not be applied in the presence of sesquioxyds of iron, aluminum, chromium or uranium, since, on the one hand the nitrates of these substances when in excess, have the property of dissolving phosphate of bismuth and thus preventing its precipitation, and on the other, when phosphoric acid is in excess, phosphates of these bases are thrown down in conjunction with the phosphate of bismuth.

Note.—Since these experiments by Mr. McCurdy were completed, we have learned from the *Comptes Rendus* that Chancel has discovered the inapplicability of his original method in presence of peroxyd of iron, and proposes to overcome this difficulty by reduction of the peroxyd to protoxyd. The details of the modified process are given on page 279. Chancel, however, still appears to overlook the fact that his process is, and is likely to remain valueless in just those cases where a new method would be most acceptable, viz. for the estimation of phosphoric acid in presence of alumina. S. W. J.

Yale Scientific School, Feb. 15, 1861.

TECHNICAL PHYSICS.

9. *On the loss of Light by Glass Shades.*—(To the Editor of Silliman's American Journal of Science and Arts)—*Sir:* In the November number of your Journal I find a notice of my experiments on the loss of light by glass shades, with an account of additional investigations by Mr. Frank H. Storer; his communication induces me to offer some further remarks on the subject.

The experiments were intended to be of a practical nature, and were tried solely in order to ascertain, (as I state in my letter to the London Journal of Gas Lighting), the loss of light occasioned by the use of the ordinary glass shades. It is not therefore quite correct for Mr. Storer to compare results obtained by the use of *flat sheets*, with the loss of light occasioned by *spherical shades*. He is right however in supposing that by "the loss of light," I intended to express "the actual diminution of the amount of light, falling for example, upon the pages of a book held near to its source, which would be occasioned by the interposition of the shades enumerated."

Prof. Verver had another object in view, and his experiments do not apply to this subject. *He* was investigating the illuminating power of gas when burnt in an Argand burner with, and without, a chimney. The

gas in these two cases is burnt under very different conditions, while in Mr. Storer's experiments, and those which I have tried, the gas was burnt under precisely the same circumstances whether a shade was interposed or not, the only difference being in the substances through which the light was transmitted.

I conducted my experiments in the following manner:—In order to avoid the trouble and inaccuracy arising from the use of a candle, I employed a gas-light as the standard of comparison throughout the trials of all the shades. This could easily be done, as in the blackened experiment chamber of the Liverpool United Gas Light Co., there is a duplicate set of apparatus, two governors, metres, burners, &c., being fixed at opposite sides of the room.

The lights, (which we may call A and B), having been made equal and their respective consumptions noticed, the first shade, (that of clear glass), was placed surrounding A, and the photometer screen moved towards it, until both sides of the screen were equally illuminated, the reading on the photometer staff was then found to be 1·118 on that side of the centre of the staff nearest A, or, in other words, the proportion of light given by B, (without a shade), was to the light given by A, (with a shade), as 1 to $\frac{1}{1\cdot118}$ or as 1 to 0·8944, or the loss of light by the use of the shade was equal to 10·56 per cent. The first shade was then removed, and the next substituted, and so on till the loss of light in each case was determined.

After all the shades had been examined, the lights were again compared, and found to be equal as at first adjusted. The quality of the gas and the descriptions of burner employed do not affect the question, provided that the same burner is used throughout all the experiments. The burners I used were "No. 3, Fish-tails," consuming 3·7 cubic feet per hour. The gas was taken from the street mains.

By using a standard light of unvarying intensity, all the errors likely to arise from inequalities in the consumption of a candle are avoided, and much time is saved in making the experiments as one or two observations with the photometer in each case are quite sufficient to ensure accuracy.

The divisions on the photometer staff do not necessarily represent candles, but the proportion that one light under examination, bears to the other, when one of them is taken as unity.

I may observe that the single experiment made with a *sheet* of common window glass was tried simply to confirm the result obtained by the globe of clear glass.

The distance at which the glass is placed from the light does not seem in the slightest degree to affect the amount of light transmitted through it. I am glad to find that my own experiments on this point are so entirely confirmed by Mr. Storer's statement. WILLIAM KING.

Liverpool United Gas Light Co., Dec. 28, 1860.

NOTE BY MR. STORER.

In reply to the courteous letter of Mr. King, I must express my regret that he has not more explicitly stated the reasons which lead him to object to a comparison of results obtained by the use of flat sheets of glass with those obtained when spherical shades are employed. That the light which is reflected back from the interior

surface of one side of a lamp-shade, of any form, would be compensated for by that similarly reflected from the opposite side—and that no similar compensation could occur in my own experiments where only single sheets of glass were used,—is evident; but I am ignorant of any experiments which go to show that the amount of light which is cut off from a given surface by the interposition of a *flat* screen is different from that which would be stopped by a *curved* screen *of the same material*. Let us suppose a precise example; in a large sheet of blackened tin we cut out an aperture, say of three or four inches diameter, and cement therein a flat sheet of ground glass and, having interposed the apparatus between a flame and the photometer, determine how much light is cut off by the glass, *i. e.*, bring the photometer to rest, as it were:—if now, having done this, we remove the flat sheet of glass and fasten in its place a segment of a lamp-shade of a material identically similar with that of the flat sheet first used, shall we find that our photometer is no longer in equilibrium? The same amount of light must have in each instance passed into the aperture in the sheet of tin;—why should it not be transmitted to our photometer in the same way in either case? The experiment cited would probably be difficult to carry out in practice since it would not be easy to find curved and flat screens of ground glass of precisely the same material, or ground equally rough. I state it merely in order that the conditions of the problem may be clearly understood, and with the desire that some proof may be given that the transmitted light would be less in one case than in the other,—a supposition not in accordance with received theories (see Art. Light in Encyclopædia Metropolitana, p. 347, §§ 42, 43); nor would it be inferred from what is known of the analogous case of radiant heat, (see LAMÉ, *Cours de Physique de l'Ecole Polytechnique*, 2de Edit. Paris, 1840, i, 309).

On the other hand, looking at the question in its practical bearing, it is clear that all lamp shades are not spherical. Witness, for example, the flat sheets of colored or ground glass used by the cars upon our street railways, the flat sheets of plain glass of the street gas lanterns, and the flat sheets of ground, enameled, or colored glass in the out-of-door lanterns of eating houses, &c.; to say nothing of the shades constructed of flat porcelain transparencies which are so commonly employed in this country to soften the glare of gas-lights; or of the lanterns of colored and enameled glass which were so often exhibited in the torch light processions of the Presidential campaign of the Autumn of 1860, and by which the phenomenon, of "loss of light by glass shades," now under discussion was so strikingly exhibited. In instituting a new series of observations, I therefore chose to make experiments, the results of which might be added to those of Mr. King, rather than to repeat the work which he had already so faithfully performed. In publishing my results, I regarded them as being merely supplementary to those of Mr. King, neither intending to institute any comparison between the two series of observations, nor directly to compare his spherical shades with my flat sheets. I intended to state only that my own experiments corroborated those of Mr. King in so far as they went to prove the *great loss of light* occasioned by the use of glass screens.

As for the experiment of Prof. Verver, to which Mr. King takes exception, he must pardon me, if I persist in maintaining that the observation does apply to the question at hand. It matters little in science, at any time, what *object* an experimenter may have in view, so long as the truth is attained and exhibited by his researches; but in the case in point, Verver's experiment, so far as it goes, applies directly to our subject. (See his own words, this Journal, Nov., 1860, [2.] xxx, 421.) Since, as I remarked in my previous note, the gas was indeed burned under somewhat different conditions in the two stages of Verver's experiment, his result must consequently be regarded as merely approximative; but before seeking to discard it altogether, Mr. King should have remembered that a globular glass shade surrounding a fish-tail burner is in some measure a *chimney*, and that therefore his own results cannot well be *entirely* exempt from the same source of error which affects the experiment of Verver. In making this remark, I would not in the least degree imply that Mr. King's observations are not most excellent. For my own part, I entertain no doubt of their accuracy;—for, throwing out the conceivable slight error to which I have alluded, his method of experimenting is unquestionably the best which is yet known. I urge only that the observation of Verver, must not be rejected.

FRANK H. STOBER.

Boston, Feb. 6, 1861.

TECHNICAL CHEMISTRY.

10. *On the Alloys of Copper and Zinc;* by FRANK H. STORER. (From the Memoirs of the American Academy, [N. S.,] vol. viii, p. 27),* Cambridge, 1860, pp. 32, 4to.

In the words of the author:—"This research was undertaken in order to ascertain what, if any, definite chemical compounds could be detected among the alloys of copper and zinc."

"Several chemists had already been led to believe in the existence of two or more definite alloys, and at the commencement of my own labors I was strongly inclined to accept this view. A more extended investigation, however, has convinced me that no such definite compounds exist. On the contrary I am confident that all the alloys of copper and zinc are simply isomorphous mixtures of the two metals, capable, as I shall proceed to show, of crystallizing at any point, from copper with only a trace of zinc down to alloys containing but thirty per cent of copper, or even less, under favorable circumstances." "The misconceptions of previous observers† have evidently arisen either from a great tendency to separate into layers, instead of immediately forming a homogeneous mixture, which the metals exhibit when fused together, or from certain striking peculiarities of structure and of superficial coloration which occur among the different alloys."

Mr. Storer has prepared a large number of alloys of copper and zinc containing different proportions of these ingredients, by methods which he has described in detail, and has found that they may all be crystallized by piercing the crust which forms upon the partially cooled molten metal and then quickly pouring off those portions of the latter which are still fluid from the crystals which have formed upon the walls of the crucible, —as in the common class experiment of crystallizing sulphur by fusion. At least he has succeeded in obtaining crystals from all the alloys which contain more than thirty per cent of copper. He has found it difficult, however, to crystallize any of the alloys which contain less than this proportion of copper since they are liable to pass through a pasty plastic state similar to that assumed by zinc or soft-solder while solidifying.

"These crystals are all octahedral, usually somewhat elongated and apparently much modified by the circumstances in which they have been formed. The edges of all of them are rounded. The octahedra are in general more largely developed upon one side than the other, apparently upon the side from which the last drippings of the melted metal fell. They are, moreover, combined together with parallel axes, which give to the crystals‡ a striated appearance; these striæ are not sharply defined,

* Communicated to the Academy, Nov. 9, 1859.

† "I must in this connection refer to and except, the valuable memoir of Karsten (*vid.* Karsten u. Dechen's *Archiv. für Mineralogie u. s. w.*, 1839, xii, 385), whose conclusions in regard to these alloys appear to be perfectly correct, with the exception of a few unimportant details. As is the case with the able research of the elder Mallet, the details of which are to be found only in the Report of the Tenth (Glasgow) Meeting of the British Association, for the Advancement of Science, p. 258, the very meagre abstracts of this memoir which are given in the chemical journals and text-books fail to convey a correct idea of the results which have been obtained,—a fact which may serve to explain the ignorance which has been exhibited, in regard to them, by subsequent experimenters."

‡ Figured in the memoir.

but their edges have the rounded character of the edges of the crystals. This general character is maintained throughout the whole series of crystals, from those of pure copper down to those of the lowest white alloys which I have obtained. No doubt can possibly be entertained of the complete resemblance of these crystals to each other throughout the series, while the striking similarity to the well-known crystals of pure copper (obtained by fusion) which they exhibit, strongly indicates that they belong to the regular system. As it is of course impossible to measure the angles of such crystals, they cannot be crystallographically determined; but the most obvious conclusion is, that they are monometric. This opinion, however, must be based rather upon analogy than on any distinct measurements.

"Upon the assumption that the crystals which I have described belong to the regular system, as well as upon the fact, which will appear in the sequel, that none of the crystals have been found to contain any larger quantity of either of their component metals than was contained in the remainder of the molten liquid from which they had separated, I have based my conclusion that the alloys of copper and zinc are isomorphous mixtures* of the two metals."

"On this hypothesis it is of course presumed that both copper and zinc are capable of crystallizing in the regular system. Copper, as is well known always occurs in forms of the monometric system. But in regard to zinc this has not been so satisfactorily proved. Not only, however, does analogy indicate that zinc should be monometric—for, so far as is known, all the metals of the Three Series of Cooke† allied to it crystallize in forms of this system—but Nicklès‡ has actually observed an instance in which it occurred in the form of pentagonal dodecahedrons."

This observation of Nicklès having been called in question by Nœggerath and G. Rose, Mr. Storer takes occasion to defend it, maintaining that it is entitled to as much confidence as any of the observations of the crystalline form of zinc which have hitherto been made.

A minute description with figures of the crystals as obtained from alloys of various composition follows. These crystals vary in size according as a larger or smaller quantity of the alloy is allowed to become solid before piercing its crust, some of those obtained by the author exceeded half an inch in length, others were quite minute.

"Very fine groups of crystals were obtained from those alloys which contained only one or two per cent of zinc. It is worthy of note, that, although these crystals have the same form and general appearance as those prepared by the same method from an equal quantity—three or four pounds—of pure copper, they are nevertheless much larger and more perfect. Since they may, for all practical purposes, be considered as crystals of copper with slight impurity of zinc, and are easily to be obtained,

* "It must not be supposed that this view supports in the least the idea of the older chemists, that alloys were mere 'mixtures' of their component metals. For the experiments of Karsten (*loc. cit.*, pp. 398, 400) have already shown that the comportment of the alloys of copper and zinc towards acids, and the solutions of various metallic salts, is that of chemical compounds, being entirely unlike that of a simple mechanical mixture of the two metals, or of a mixture of several alloys."

† Memoirs of the Amer. Acad., [N. S.,] v, table to p. 256.

‡ Ann. Ch. et Phys., [3,] xxii, 37.

it would almost seem advisable to add one or two per cent of zinc to the metal employed in preparing specimens of crystallized copper for the cabinet. A similar case is presented by lead, which is very readily crystallized when it contains a little antimony: a fact well exemplified by the beautiful cups of crystals of *Krätzblei*, which are prepared by partially cooling the metal in ladles, at the Fraukensharner smelt-works near Clausthal, and doubtless in other localities in the Hartz."

"Since the crystals rich in copper which have just been described do not possess in any marked degree the yellow color peculiar to brass, they are somewhat less interesting than those obtained from alloys containing more zinc. Crystals of the latter can be obtained with the greatest ease by remelting old brass, or, better, by filling a Hessian crucible from the molten metal of the pots of a brass founder, in which case all annoyance from the formation of a false crust of mixed oxyd of zinc and metal is obviated." * * *

"The most perfect individual crystals were obtained from a quantity of brazier's solder which had been prepared at the foundry of the Revere Copper Co., in Boston, by fusing together 50 parts of copper with 50 parts of zinc. When an alloy of about this composition solidifies, and especially if it be suddenly cooled—as happens when it is poured into iron ingot-moulds,—it assumes, as is well known, a highly crystalline structure, consisting almost entirely of a mass of coarse fibres which shoot out from the points at which the alloy comes in contact with the cold metal of the mould. In the instances which have fallen under my notice the ingots being from an inch to an inch and a half in depth the fibres have shot up three quarters of an inch, or more, from the bottom of the ingot, leaving only a sheet of metal about a quarter of an inch in thickness on top, which had cooled more slowly by contact with the air. * * * On removing portions of this upper layer, its inferior surface will be found studded with crystals, often of great beauty, while others frequently occur impacted among the fibres themselves. Indeed, these fibres, although described by Calvert and R. Johnson* as prismatic crystals, indicating that the alloy Cu Zn is a definite chemical compound, are evidently nothing more than collections of octahedral crystals, similar to those which form the fibres of sublimed sal-ammoniac and of several metals."†

The tendency to shoot out into fibres just alluded to which extends over quite a space from alloys containing 57 or 58 per cent of copper down to those containing only 43 or 44 per cent is next discussed. It is of peculiar interest on account of its practical bearing;—"alloys at the upper limit of this fibrous tendency being the lowest—*i. e.*, richest in zinc—which can be rolled or subjected to the various processes by which metals are wrought. Singularly enough, at a point just beyond the limit at which the fibres cease to be apparent, viz., at 60 per cent of copper, an alloy of peculiar homogeneity occurs;—its fracture as seen when small bars are broken, being smooth and compact, and entirely unlike either the coarse, irregular, stringy fracture of alloys richer in copper, or that of alloys containing only a little more zinc, upon the fracture of which small bundles of fine crystalline fibres are often apparent.

* Journal of the Franklin Institute, [3,] xxxvii, 200. See also Phil. Trans., cxlviii, 367.

† *Vid.* Savart, Ann. de Ch. et Phys., [2,] xli, 65.

"This alloy readily admits of being rolled, either hot or cold, and may be subjected to the operations of hammering or drawing without detriment, while alloys containing only a few per cent more copper can be rolled hot only when the sheets are raised to a very high temperature. * * *

"In the preparation of the alloy of 60 per cent copper, now so extensively used for sheathing vessels under the name of Muntz's sheathing or yellow-metal,—also known as malleable brass,—it is the custom of founders to reserve a portion of the zinc which has been weighed out for a charge, until the alloy in their pots or furnace has become sufficiently hot; the last portions of zinc are then added in small pieces, a sample of the alloy being tested after each such addition. This is done by dipping out a small portion of the melted mass and pouring it into a mould; a little ingot, five or six inches long by an inch or less in thickness, is thus obtained, which after cooling, is broken on an anvil, and its fracture observed. If this does not exhibit a smooth and homogeneous surface, more zinc is added to the alloy. The accuracy with which an experienced workman can thus obtain the desired alloy is truly astonishing, the more especially since this homogeneous alloy is confined within very narrow limits."

"It is stated by founders that the alloy of 60 per cent of copper and 40 per cent of zinc will present almost precisely the same homogeneity of fracture, whether the test ingot prepared from it be cooled slowly, by exposure to the air, or rapidly, by plunging it into cold water, while alloys containing either more or less than 60 per cent of copper are liable to assume different structures, according as they are cooled with greater or less rapidity. Two ingots are therefore sometimes cast, on each trial of the alloy, one of which is cooled in water and the other in air for comparison. This double test is, however, deemed superfluous by skillful workmen."

"I may remark in this connection, that I have repeatedly obtained crystals, by the method of partial cooling, from portions of melted yellow-metal taken from the founder's pots at the moment it had afforded them a satisfactory test. These crystals are in no wise different from those obtained by myself from alloys of almost identical composition.

"Although, as has been stated, the tendency to form fibres seems to have ceased at the alloy containing 60 per cent of copper, I cannot but think that the limit of its influence is less clearly defined than the "test" of yellow-metal founders would seem to indicate. In the circumstances under which this test is applied, it is doubtless true that no fibres are formed; but it is a matter of experience with manufacturers of yellow-metal, that the texture of the large ingots from which the sheets of sheathing are rolled is no longer so homogeneous as that of the small test ingot; they affirm also that this texture may vary greatly, according to the conditions in which the ingot is allowed to cool. It is evident, therefore, that during the processes of hot and cold rolling, and of annealing, to which the alloy is subsequently subjected, its texture may undergo various changes; while it is certain that the comparative durability of the sheathing, when exposed to the action of sea-water, must in great measure depend upon its relative compactness. If it be open and porous, as would be the case if a trace of the fibrous structure were present, it is clear that the sheathing would soon be destroyed;—not only because the salt water would come in contact with its interior portions, but also since the individual crystalline fibres of the alloy would doubtless resist its action more completely than the amorphous matter attached to them or contained in their interstices; from this a voltaic action would be produced, which could not fail to promote the corrosion of the alloy."

(*To be concluded.*)

II. GEOLOGY.

1. *On Prof. J. W. Dawson's papers on the Coal.*—Prof. J. W. Dawson, LL. D., of McGill College, Canada West, has lately published in the Proceedings of the Geological Society of London two very interesting memoirs:—one concerning the vegetable structure in coal;* the other on a terrestrial mollusk, a *Myriapod* and some new species of reptiles from the coal of Nova Scotia.

The formation of the coal and the composition of its combustible matter may be considered as settled questions. But we are still far from being well acquainted with the true nature of the coal plants, and with their generic and specific affinities. Fossil plants are found preserved in two different ways. In the shales and the sandstones the outline of the vegetable is marked just as it would be on the stone by the pencil of a lithographer; but no trace of internal structure is preserved; and as these remains are mostly broken parts of stems and of leaves, crushed cones, scales or blades, nutlets and prints of various forms left on the bark of some trees at the point of attachment of the leaves, it is nearly impossible to determine with precision the species to which such fragments belong, or at least to get any indication about their mode of vegetation and their relation to plants now living.

In the coal on the contrary we find a few remains of internal organism, chiefly vessels of various appearances. But in the compact, homogeneous matter of the coal, every trace of external structure of the plants having disappeared, these isolated vessels can not, in any way, indicate the form of the plant to which they belong.

It is especially in treating the laminæ of mineral charcoal intermixed with compact coal by chemical maceration, that Prof. Dawson has been able to separate the vegetable fibre and to study the form of some of the vessels. The result of these researches is satisfactory to this point; it proves by a direct experiment that the coal is a compound of different species of plants. Though many palæontologists had already come to the same conclusions by researches of the same kind, Prof. Dawson is the first who has succeeded in clearing the woody fibre perfectly from every particle of amorphous substance, and thus his assertions are more conclusive and more reliable. Nevertheless, some of these assertions are open to critical discussion.

The first question which the author proposes to elucidate by his researches (the one which relates to the precise genera and species of plants which have contributed the vegetable matter required for the coal) is perfectly well answered by himself in a note from a former paper where he says: *I have little confidence in the establishment of genera or species, on the minute structure of fragments of wood.* Of course if fragments of fossil wood can not indicate genera and species by their internal organization, *à fortiori*, neither can isolated vessels do it. The second question concerning *the causes which have produced the different qualities of coaly matter observable in the different parts of the same bed, or in different beds in the same coal-fields*, does not appear to be satisfactorily answered. Suppose we admit Liebig's theory, that coal results from the submersion of vegetable fibre:—then since the thin laminæ of mineral charcoal,

* Vol. xv, 626.

generally no thicker than the $\frac{1}{30}$th part of an inch, alternate sometimes with equally thin layers or laminæ of compact coal, the question arises how could such thin layers be exposed to atmospheric influence while the intermediate laminæ were transformed to solid coal by immersion? The supposition *that the mineral charcoal represents the woody fibre of trees subjected to atmospheric decay, while the bark of those trees appears as compact coal along with such woody and herbaceous matter as might be imbedded before decay had time to take place*, is contradicted by numerous observed facts. In the coal-fields of the United States the layers of charcoal most frequently show prints, easily identified, of the species predominant in the shales overlaying the coal. Thus one bed (No. 1B Coal) has, especially in its charcoal, blades of *Lepidostrobus* and leaves of *Lepidodendron*. Others have in abundance the prints of the bark of *Calamites*, *Lepidodendron*, *Stigmaria* and even *ferns*.

The question whether *Stigmaria ficoides* be the root of a *Sigillaria* is far from being settled, and though the assertion that *Stigmaria* is found in every bed of fire clay is true, the deduction drawn from this fact, on the assertion of some authors—that *Stigmaria* is not found in the coal or in the shales overlaying it is without any foundation whatever. Some beds of coal have been formed by *Stigmaria* only. Whole strata of black laminated roof-shales contain only remains of *Stigmaria*.

Neither the form or the size of the scalariform vessels can be admitted as a generic character; the form of the perforations varies on the same vessel passing from round to oval, to equilateral and to true scalariform shape by gradual and inappreciable transitions. The size of the vessels varies according to the size of the same plant.

One of the most interesting conclusions reached by Prof. Dawson is that the small cylindrical filaments, resembling black threads, so abundant in the coal and mineral charcoal are composed of *bundles* of scalariform vessels inclosed in a sheaf of woody fibres. This is, says the author, precisely the structure of the vascular bundles of the petioles of ferns. It is certain that the writer has seen these filaments generally in connection with crushed stems, especially with crushed *Calamites*.

The vessels figured 8 to 12 of pl. 18, apparently belong to some species of *Stigmaria*, especially to *S. ficoides* (compare Corda's *Beytraye*, tab. 13). That tissue of this kind constitutes by far the largest part of the mineral charcoal is a proof of my assertion, that *Stigmaria* enters largely into the formation of the coal.

It is scarcely possible now to refer the genus *Sigillaria* to *Cycadea* or to the *Coniferæ*. Neither the internal structure nor what we know of the external forms of species of this genus, the leaves, the fruits, &c., can show such an analogy.

Prof. Dawson can not with certainty affirm the presence of tissue of true Conifers in the coal. This agrees perfectly with the result of ten years of explorations by the writer in the coal measures of the United States and its flora, where no trace of a true Coniferous plant has thus far been found.

The writer does not think that the coal measures of Nova Scotia give a true exhibition of the general formation of the coal. The coalfields of that country bear testimony to such continual disturbance by the repeated movements of the surface, repeated overflows, sudden invasions of littoral

debris, sand, pebbles, &c., that any general conclusion founded on the study of such geological phenomena, would be contradicted by what we see in the distribution of the coal strata in the coalfields of the United States, at least in those west of the Appalachian mountains.

The general conclusions of this paper, appear to be perfectly just, though not necessarily derived from the microscopical researches of Prof. Dawson. But, if this assertion of the author is true; that the *sigillariæ especially, have contributed to the vegetable matter of the coal;* what becomes of the former conclusion: that the filaments so abundantly found in the coal and mineral charcoal are bundles of fibrous vessels of petioles of ferns. Moreover we must deny the prevalence of *Calamites* and *Sigillariæ* in the roof shales, at least, in the coalfields of the United States. Each bed of coal, according to its age, or geological horizon, has some plants peculiar to itself predominating in the shales, and the same plants are found, apparently in the same proportion, in the whole thickness of the coal.

In his second paper,* Prof. Dawson most satisfactorily confirms a former discovery made by himself and Sir Charles Lyell, of the presence of terrestrial animals in the coal measures of Nova Scotia. In like circumstances, viz., in the hollow petrified trunk of a standing tree, he has found numerous well-preserved specimens of the same land shell, *Pupa vetusta* Daw., before discovered at the same locality; some remains of a new genus and species of an articulated animal, resembling a Myriapod, *Xylobius Sigillariæ* Daw.; and portions of two skeletons of animals belonging to a new *reptilian* genus, *Hylonomus* Daw., two species of which *H. Lyellii* Daw., and *H. aciedentatus* Daw., are figured and described in the paper.

Every geologist will recognize the great importance of this discovery, as respects both palæontology and the history of the coal formations. This history is slowly unfolding itself by the unwearied researches of a few true lovers of science, who like Prof. Dawson, endeavor to compensate the want of coöperation in such a thankless field of science as that of fossil botany, by incessant and conscientious labor. Discoveries of nearly the same kind as those of Prof. Dawson, have been made lately both in Europe, and in the United States. Goldenberg has found in the coal measures of the Vosges, in France, new species of *Blattinæ*, *Thermites*, *Dyctioneuron*, &c., and five wings of a *Blattina* have been lately found in the lowest coal of Arkansas. L.

2. *Thirteenth Annual Report of the Regents of the University of the State of New York*, (for 1859), 128 pp. 8vo. Albany, N. Y.—The cover and title page of this Report bear the date of 1860, with the addition, "made to the Senate, April 10, 1860." It contains in addition to the usual annual statement of the business affairs of the State Cabinet, six Appendises. Of these, A, B, C and D are catalogues of various collections and donations. The Appendix, E, is an interesting paper entitled "Ancient Monuments in Western New York, comprising the results of explorations by T. Apoleon Cheney, Civil Engineer, etc., 1859." It is illustrated by 24 plates and a map of various mounds, excavations and antiquities of the aboriginal inhabitants of the country.

Appendix (F) has a separate title page thus: "Contributions to Palæontology, 1858 and 1859. By James Hall, *Geologist* and *Palæontologist*, etc." We are thus particular in noticing these dates because

* Quart. Jour. Geol. Soc. London, xvi, 268, 1860.

we have been informed that Prof. Hall has introduced into this paper under new names several species which have been described by other authors during the year 1860. Should this Appendix be separated from the Report and circulated with no other information as to the date than what is given on the title page, palæontologists in other countries may possibly be led to quote its contents with a date as far back as 1858.* From what appears upon the cover of the Report itself most people would suppose the date of publication to be April 10, 1860. Such however is not the fact. We have ascertained that "the first lot of (this) Regents' Report was delivered (by the Printer) Dec. 17, 1860, to the Regents of the University," (letter from C. Van Benthuysen, the printer). We have evidence that important changes were introduced into the text of the Geological part as late nearly as the above date, if not even later. Such additions should have been indicated by an appropriate date either in the text or on the cover of the Report. We regret extremely to feel compelled to make this statement. But having been long aware that similar changes had been made in the 12th Report, after it had been in part circulated and noticed in this Journal (xxviii, 149), we cannot permit this recurrence of the same practice to pass withotu our earnest protest. We would therefore respectfully suggest to the Regents that hereafter they should take every precaution to prevent this confusion of dates in the publications that issue under their authority. The interests of science demand that all misunderstandings between naturalists should be guarded against, and nothing can be more likely to make a man of science feel that he has been unfairly dealt with than to see another obtaining priority over him by fictitious or indefinite dates. Another Regents' Report will be due either in the present month of March or perhaps in April. Let it be printed and circulated *as presented* at once, or if it be delayed to accommodate authors, let the date of actual *publication* be given as well as the date of presentation to the Senate.†

Prof. Hall's paper contains notices of about one hundred (mostly new) species of fossils from the Silurian and Devonian rocks of the United States. He proposes the following new genera of Brachiopoda:

1. Skenidium.—This genus if adopted will include several species heretofore referred to *Orthis;* the dorsal valve flat and the ventral valve of a pyramidal shape.

2. Amboccelia.—The types of this group are said to be *Orthis umbonata*, Conrad, and *Spirifer unguiculus*, Sowerby. It is therefore the same as McCoy's genus Martinia. (See McCoy's British Palæozoic Fossils, p. 377.)

3. Vitulina.—The species resemble *Orthis* with the dorsal valve flat,—the ventral valve pyramidal,—ribs large.

4. Leiorhyncus.—Shells with the general form of *Rhynconella* but with the plications more rounded, and rarely or never continued to the lateral margins

* In confirmation of this suggestion we have received (January 19,) a brocheure from the author entitled: "*Contributions to Palæontology*, 1858 *and* 1859 *By James Hall, Geologist and Palæontologist, etc.* (From the Thirteenth Annual Report of the Regents on the State Cabinet,) pp. 55–128, 8vo." On the cover there is the same title but the date there reads, "1858 *and* 1859 *with additions in* 1860." This is still too indefinite.

† No principle is more thoroughly established in the ethics of science than that the date of *publication* and not the date of *composition* or *printing*, settles the question of priority of authorship. Hence has arisen the practice of Authors of distributing separate copies of Memoirs in advance of publication of an official report—thus securing the earliest practicable date of *publication*. To this course no objection can be made, but no changes from the original text are admissible.

which are more compressed than in *Rhynconella* proper. The internal structure appears, so far as ascertained, to be the same as in *Meristella*" = (*Athyris pars*)?

5. MERISTELLA.—Intended to include that group of species of *Athyris* (McCoy) which has *A. tumida* Dalman, for the type. It is not probable that this proposal will be accepted because, if McCoy's genus is to be divided, then we have three names (long in use) to be accommodated, that is to say, *Athyris*, *Spirigera* and *Merista*. No new names can be admitted until all the old ones shall have been provided for.

Athyris, must be retained for the group with the beak of the ventral valve imperforate and closely incurved and with the mesial septum in the dorsal valve. (Type *A. tumida*.)

Spirigera, must include those with the beak of the ventral valve perforated and a rudimentary mesial septum in the dorsal valve. (Type *S. concentrica*.)

These two genera are limited as above by DAVIDSON in his "Introduction to the Classification of the Brachiopoda," pp. 84–87: and by F. ROEMER in the last edition of Bronn's "Lethaea Geognostica," vol. i, Pt. 2, p. 330–331. It is quite clear that if *Meristella* be retained then either *Athyris* or *Spirigera* must be suppressed in order to make a vacancy for it. There is no probability of this being agreed to by palæontologists. The other genus *Merista* will no doubt hold good for those species which have the shoe-lifter process in the ventral valve.

Prof. Hall describes a new genus of Crinoids under the name of *Cheirocrinus*, and also proposes two new genera of trilobites *Barrandia* and *Bathynotus* to include the peculiar forms from Vermont heretofore referred by him to the genus *Olenus*. It has perhaps escaped Mr. Hall's notice that McCoy has published a trilobite genus "*Barrandia*" in the "British Palæozoic Fossils," p. 149. McCoy's genus appears to be disputed but still it must be retained until it is clearly shown to be without foundation.

3. *Geological Surveys.*—TENNESSEE. Prof. Safford is now publishing the first volume of his Report on this State. It will be in two parts. 1st. The Physical Geography of Tennessee, 2d. The Geological Structure and the Formations of Tennessee. It is in 8vo, and will contain a map of the State and 20 or 30 plates, chiefly fossils. Its completion is expected in about three months. A *second volume* to be published hereafter, will contain Part 3d, the Minerals and mineral resources of the State, and Part 4th, the Agricultural resources.

KENTUCKY.—The publication of the fourth and concluding volume of this Survey is in the hands of Dr. Robert Peter, of Lexington, Ky. The matter will form a large and very valuable volume. The Legislature ordered 7000 copies to be printed. The completion of the work may be expected during the coming summer, if political causes do not arrest the progress of the work.

TEXAS.—We learn with regret that the removal of Dr. Shumard (noticed on p. 124) was caused solely by political considerations—his successor being an "Old Texian," which Dr. Shumard was not! An intimation that influential scientific names had been used to effect this change appears to have no foundation in fact, and was probably intended only to justify so remarkable a step. The effect of the change will probably be to abolish the work at the next session of the Legislature.

4. *Trilobites of the Wisconsin 'Potsdam.'*—Upon examination of the "small trilobites" from the Potsdam sandstone from "Black River Falls," Wisconsin, presented to the Boston Society of Natural History by Prof. Daniels, as mentioned on page 310 of vol. vi of the Society's Proceedings, they are found to be identical with the *Conocephalites minutus* from Keeseville, N. Y. Accompanying them are fragments of two or three

other small small trilobites too indistinct for absolute determination; one *seems* to be nearly allied to the genus *Bathyurus* (Billings). The specimens also contain a *Theca*, apparently *T. triangularis* (Hall); as also a few *Lingulæ*, which, while they *may* be *L. prima* of New York, yet vary so much that their identity seems hardly possible. F. H. BRADLEY.

5. *Chrome Garnet.*—I have recently discovered a beautiful emerald green garnet in Oxford, Canada, in calcareous spar with millerite. It is massive, granular, or in transparent dodecahedrons and resembles ouvarovite, but is essentially a lime-alumina garnet with 6·0 p. c. of oxyd of chromium. I shall soon send you a full description with an analysis.

Montreal, Jan. 21st, 1861. T. S. HUNT.

III. ZOOLOGY.

1. *Contributions to the Natural History of the United States;* by Louis Agassiz. Vol. III.—*Acalephs in general—Ctenophoræ.* Nothing goes farther to prove the necessity of a wide and far-reaching study of animate nature than the facts brought to light by the examination of jelly-fishes. It is the misfortune of most zoological text-books, and of popular science in general, that such stress is laid on the structure of Vertebrata, so many illustrations drawn from them, and so much emphasis given to them, as the head and type of the animal kingdom, and the scale by which all other animals are to be measured, that the student gets to look on everything else as something intrinsically inferior in character and uncertain in position.

This wrong idea is well illustrated by the expression Vertebrates and Invertebrates, as if the first were a division equal to, and co-extensive with, the second. Invertebrates are a common refuge for all creatures so unfortunate as to have no back-bone; just as Infusoria furnish a convenient reservoir, into which to pour all small objects that cannot easily be seen. Again, naturalists are led, by such partial studies to make many false generalizations; such as, that the rapidity and force of motion are in direct ratio to the size of the nervous centres and to the perfection of the muscular system; whereas we see such medusæ as *Coryne* (*Sarsia*) and *Pleurobrachia* executing swift and complicated motions, though they have neither nervous nor muscular systems, properly so-called. Then the incorrect homologies that are attempted: the comparison of the head-ganglion of a cephalopod to the brain of a mammal; the structure of a worm to that of *Petromyzon;* and of the limbs of an insect to the limbs of the higher vertebrates. To this may be added the false ideas of rank among the different groups; placing the whole of the Articulata below Vertebrata; the whole of the Mollusca below Articulata, and the whole of the Radiata below Mollusca. Whereas no such comparisons can be made between the different plans of creation, and no such systematic subordination established. The squids, among Mollusca, so far as they can be compared, stand certainly as high as any of the crabs, and possibly higher than the lamprey eels. The radiate *Spatangus* is, without doubt, a more complex mechanism than the molluscoid *Vorticella*, or the articulate *Rotifera*.

Books like this third volume of "Contributions" will do much to give to the mass of scientific men, those broad and philosophical views, which are now almost confined to the leaders. We here have revealed to us, in all its richness, a class which includes in its apparently humble

limits some of the most extraordinary phenomena of generation, of growth and of life.

The first chapter treats briefly of the history of our knowledge in this branch, from the time of Aristotle, (who confounded sea-anemones and jelly-fishes under the common term *nettles*), down, through many barren centuries, to near our own day, when Rondelet, three hundred years ago, published figures of medusæ, with some observations of his own. Two centuries more added comparatively little to the store of information; O. F. Müller, however, had published the *Zoölogia Danica*, the colored plates of which are fitting forerunners of the magnificent drawings of Lesueur, illustrating the numerous acalephæ, collected by him and his companion, Peron. The *System der Acalephen* by Eschscholtz, which not only embodied all heretofore known, but was further enriched by the material accumulated during two voyages round the world, served to show the great number and variety of these animals. The important exploring expedition of Quoy and Gaimard in the Physicienne and the Astrolabe; of Prof. Dana, in the expedition under Capt. Wilkes; and of Fitzroy in the Beagle, have done much to complete the necessary specific knowledge.

The first discoveries of Sars in the embryology of medusæ are striking illustrations not only of the gradual way in which zoölogical truths are arrived at, but also of the mistakes which come from a partial knowledge of any animal. They show that we cannot judge the embryo from the adult, or the adult from the embryo; and, what is yet more important, they exemplify the fundamental fact, that the embryo of a superior class resembles the perfect creature of an inferior class, in the same type. It was in 1829, that the Norwegian naturalist described a new genus of polyps under the name of *Scyphistoma*, and another peculiar one, of medusæ called *Strobila*. In 1841, through his own discoveries and those of other naturalists, he was enabled to prove, 1st, that *Scyphistoma* was the first stage of *Strobila;* 2nd, that *Strobila* was the fixed stock, which by transverse division, produced individuals of the genus *Ephyra;* 3rd, that a species of *Ephyra* was the young of *Aurelia aurita;* and 4th, that the eggs of *Aurelia aurita* produced a species of *Scyphistoma;* the two ends of the line of growth were thus joined and the cycle of the species perfected. In this way were the foundations laid for a general embryology of the covered-eyed medusæ. The connection between the so-called hydroid polyps and the naked-eyed medusæ, was yet to be shown. In 1843, Dujardin supplied the wanting link, by discovering that the medusa *Cladonema* was the offspring of the hydroid genus *Syncoryne*. The other two orders, Ctenophoræ and Siphonophoræ, do not present embryological difficulties of the same sort; the first named have young resembling the parent, though with shorter rows of flappers; somewhat as spiders, among insects, have no proper larval condition, but gain another pair of legs on coming to maturity.

It would be natural to challenge the standing of a class, containing such seemingly heterogeneous groups. What have they in common? Not a common embryology:—not a common detail of structure:—least of all a common *form*. Here then we are compelled to resort, to what we should daily resort to, without compulsion, the *metaphysics* of zoölogy. If we agree to call that a class which shows a plan of structure carried out in a peculiar way; then two questions come up: 1st, what is the peculiar way in which the general plan of radiation is carried out among

the Acalephs? and 2d, do all the so-called Acalephs really agree in the way in which the plan of radiation is through them exemplified? The peculiar model, so to speak, of a jelly-fish may best be seen by contrasting it with a polyp; for instance an *Actinia*;—and first it is plain that the jelly-fish carries the so-called stomach of the polyp turned *inside out*, and forming the proboscis (compare *Rhizostoma*, *Cyanea*, &c.); even where there is no proper proboscis, the stomach is not inverted into the body (*Bolina*, &c.). What is commonly spoken of as the stomach of a medusa is nothing more than the visceral cavity, into which open the radiating tubes, just as the free chambers of the polyp open into its visceral cavity. The jelly-fish has however a circular tube, running round the edge of the disc, and making a common receptacle for all the radiating tubes; a feature not found in the polyps. Then the fleshy interambulacral partitions, so thin and regular among polyps, are thickened, among medusæ, and coalesce above and below, leaving only narrow, radiating tubes through their gellatinous mass. With the model thus hastily sketched, all Acalephæ will be found to agree. The Ctenophoræ, which Quoy and Vogt would (no one can tell why) refer to Mollusca, are readily homologized. Taking *Idyia* as an instance, there is the visceral cavity, the circular marginal tube and the radiating tubes leading into it. The peculiar appearance of this particular group rises from their unusual height, their little rows of tentacles, called "flappers," and the arrangement of their parts in 8's, instead of 4's. It is in the order of Siphonophoræ that the triumph of class homologies has been the greatest;—here we are forced at once to take an embryological view, just as we are in considering the lampreys in connection with the fishes, or the marsupials, in connection with the mammals. Knowing that hydroids are one stage of true Acalephæ, and taking *Hydractinia* in comparison with any siphonophorous community, like *Velella*, we see that the polymorphous individuals may be compared in the two; *Hydractinia* is attached, *Velella* is free; the expanded base of *Hydractinia*, from which rise the different hydræ, forms in *Velella* the swimming vesicle. If further proof were needed the "tentacles" (hydræ) of *Velella* actually produce *free medusæ*. Such elongated communities as *Diphyes* may, in like way, be homologized; there are a few medusoid individuals ("swimming bells"), then hydroids ("polyps") protected by a "scale" and bearing on their proboscis male and female medusæ buds ("ovaries").

Not the least interesting addition to the hydroid medusæ is the discovery, by Prof. Agassiz, that *Millepora alcicornis*, of the Florida reefs, belongs to this division, and not to the actinoid polyps. It becomes hereby probable, that the whole of Milne Edwards' division *Tabulata*, which includes *Millepora*, *Pocillopora*, &c., is to be considered as among the Acalephs; and, further than this, his Rugosa, which include only fossil genera, are so distinct in many respects from the true stony corals, and so remind us in some genera, of the *Strobila* stage among the covered-eyed medusæ, that we are led to suspect *their* affinity also with the acalephæ. Be this last as it may, it is now pretty well established that jelly-fishes are represented, through the millepores, in some of the earliest geological formations; a point of the greatest importance in palæontology.

A proper review of Part II, on Ctenophoræ, could not be brought within the limits of this short notice. It consists of a critical analysis of Ctenophoræ in general; a consideration of their natural families; thorough

anatomical investigations of the North American species of *Bolina*, *Pleurobrachia*, and *Idyia;* a systematic tabular view of the known Ctenophoræ; and a table of their geographical distribution. Among the most interesting of these investigations are the variations of form as dependent on the development of different "spheromeres" or radiating wedges of which the body is made up; and the remarks on the circulation of chyme.

The illustrations by Sonrel, Burkhardt, and Prof. Clark, are unrivalled in their way; Sonrel's large drawing of *Cyanea arctica* is a miracle of skill and patience. T. L.

Note.—The important chapter on individuality among acalephs is not mentioned here, because it has already appeared in this Journal, (vol. xxx, 142).

IV. ASTRONOMY.

1. *Translation of the Sûrya-Siddhânta, a Text-book of Hindu Astronomy*, (Journal of the American Oriental Society, vol. vi).—We take pleasure in bringing to the notice of our readers, and especially those who are students of astronomy, this highly important contribution to the history of that science. Ever since India began to open itself to the knowledge of the western nations, about the middle of the last century, it has been well known that the Hindus have a peculiar system of astronomy, which is neither recent in its origin nor inconsiderable in its development. The curiosity and interest which this fact could not fail to awaken, are attested by numerous works which relate, wholly or partly, to the Indian astronomy—the productions either of European savans, like Bailly, Delambre, Biot, or of Englishmen resident in India, as Davis, Colebrooke, Bentley, Warren, and many others. It is remarkable, however, that while so much has been written on the subject, no work has appeared before the present, from which the occidental scholar could find out what the Indian astronomy is,—how it exists, as a system of theory and practice, a science and an art, in the Indian mind. It is the want of any such work, which has given rise to the publication before us. Rev. Mr. Burgess, formerly missionary of the American Board of Missions, while laboring among the Marâthas of western India, was called upon to prepare an astronomical text-book for the instruction of the natives. In executing this task, he was, naturally and almost unavoidably, led to study the astronomical system of the Hindus themselves. He found, however, much to his surprise, that there was no published book, from which he could obtain, in a comprehensive and systematic form, the information which he wanted. The perception of this deficiency suggested the idea of supplying it. To facilitate for others the acquisition which cost him so much time and trouble, he determined to translate one of the *Siddhântas*, or astronomical treatises, of which there are a considerable number (for the most part, yet unpublished) in the Sanskrit language. He selected for this purpose the Sûrya-Siddhânta, which appears to be the most highly esteemed and the most generally used of these works. In preparing his translation, and in gathering matter for an explanatory commentary, he received the aid of native Pandits. He left India, indeed, without having accomplished his design; but desiring still that his work should be made available for the

cause of science, he placed his collected materials at the disposal of the American Oriental Society. The result appears in the sixth volume of the Society's Journal, in an article of 350 pages (more than half the volume), of which a separate edition has also been struck off, and can be obtained, at $2.50 a copy, from the Society's agents (New York, John Wiley, 56 Walker st., etc.). It has been prepared by Mr. William D. Whitney, Professor of Sanskrit in Yale College, and Corresponding Secretary of the American Oriental Society. In revising the translation, he has aimed to make it, not only faithful, but also in some degree intelligible, by expanding the condensed expressions of the original, and by giving English equivalents for the scientific, technical, and mythological terms which abound in it. In the last case, however, the demands of the Sanskrit scholar are satisfied by adding the original terms enclosed in marks of parenthesis. We say, "*in some degree* intelligible"; for a mere translation, however skilfully executed, would of necessity present numerous and almost insuperable difficulties to the occidental reader. These difficulties arise, partly, from modes of conception peculiar to the Indian mind; partly, from peculiarities in the methods and processes of the Hindu arithmetic and geometry; partly, from the fact that the work is composed in Sanskrit verse,—a mixture of poetry and science which is familiar to the Hindus, though to our view incongruous and absurd. The style of the original is exceedingly condensed and cramped, and its language often vague and ambiguous. In fact, it was never intended for easy reading. It was not meant to be an open source, from which an unlearned man could draw out for himself the knowledge of astronomy; but rather a secret repository of astronomical science, accessible to the initiated, and employed by them for the uses of instruction, the teacher supplying in his own oral comments the indispensable explanation.

To remove the difficulties of which we speak, Prof. Whitney has added a copious and elaborate commentary, which follows the translated text from point to point, and not only illustrates its meaning, but compares its principles and processes with those of European astronomy. It presents the results of long and careful study in a perspicuous and attractive style, which cannot fail to interest all who are capable of taking an interest in the subject. The demonstrations which are given to show the correctness, or (as the case may be) incorrectness, of the Hindu rules and methods, are drawn out with much fullness and clearness, and offer no difficulty to those who have a fair acquaintance with the elements of geometry and trigonometry. It appears from an acknowledgment in the introduction, that Mr. H. A. Newton, Professor of Mathematics in Yale College, has rendered important assistance in the preparation of this commentary.

The subject of Eclipses is treated with particular care. This may be regarded, indeed, as the centre of Hindu astronomy, the great end of astronomical pursuits among that people being the prediction of these phenomena. Besides his remarks in illustration of the text, Prof. Whitney has given an extended calculation of the lunar eclipse of February 6, 1860, made by himself in strict conformity with the data and methods of the Sûrya-Siddhânta. We find also a calculation, according to Hindu data and methods, of the solar eclipse of May 26, 1854; this, however, was mainly prepared for Mr. Burgess by his Hindu as-

sistant, and it illustrates, as we see from the accompanying criticisms, the negligence and looseness with which the methods of their books are applied in practice by the native astronomers.

One of the most interesting chapters is that which relates to the *nakshatras*, or lunar asterisms, a series of star-groups, twenty-eight in number, encircling the sphere, and seemingly known to the Hindus from a very early period. Prof. Whitney, in his learned and masterly discussion, compares these Indian *nakshatras* with the *sieu* of the Chinese and the *manâzil* of the Arabs. He comes to the conclusion that they did not originate in India; but he shows at the same time, that they were not brought, as Biot supposed, from China into India; if they originated in China, they must have been carried first to some country of central Asia, where they received a modified form, and thus afterward passed into India on the one hand, and into Arabia on the other, to undergo further special modifications in each of these countries.

The relations of the Indian science of astronomy to that of the Greeks are often noticed in the course of the commentary, and form the subject of a closing note, which sums up in a very clear, and, to our mind, convincing manner, the results to be drawn from the foregoing expositions. The conclusion, in brief, is this, that the Hindu science must be regarded as an off-shoot from the Greek, planted not far from the commencement of the Christian era (probably before the time of Ptolemy), and attaining its fully developed form in the course of the fifth and sixth centuries. Among the points of agreement between the two systems, the most striking is the use of epicycles for representing the motions, and calculating the positions, of the planets. This is a cardinal feature in both systems, and is essentially the same in both. There is no reason to suppose that the Greeks borrowed it from the East, but much reason for believing the contrary. To regard it as originating in India is opposed to all we know of the scientific character and tendencies of the Hindus. Acute as they are and fond of speculation, they have never shown an aptitude for the study of external nature, and could not have made the exact and long-continued observations of the stars, on which that system must have been founded; their books, indeed, contain no records of astronomical observations. The division of the circle also presents traces of a Greek origin; and the Greek names for *minute*, *hour*, *centre*, are found in the Hindu text-books. The Greeks, in fact, are, not unfrequently, referred to in the treatises of earlier date, as authorities on astronomical subjects. But the Hindus, if they borrowed the Greek astronomy, have set upon it the stamp of their own thinking; they have given it, in general, an arithmetical, instead of a geometrical, form; and have made a really valuable improvement by substituting, in their calculations, the sines of arcs for the chords which were used by the Greek mathematicians.

We must add, however, that Mr. Burgess does not accept these conclusions. In a note appended to the article, he sets forth his dissenting views, maintaining the originality of the Hindu science, and contending that the features common to the two systems were either developed independently in both countries, or were imported into Greece from the East.

The value of the work is much increased by a copious index, which furnishes to those who may not care to study it as a whole, the means of finding readily all that it contains on any particular topic.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Interesting discoveries of Saurian and other fossil remains in the Red Sandstone of E. Pennsylvania, in a letter from* C. M. WHEATLEY, Esq., of Phœnixville, Pa., to one of the Editors.—I have within the last three months made some important discoveries in our black shales of the Phœnixville Tunnel. I have found a true "*Bone Bed*" and have obtained from it *Saurian Bones* of very great interest, whether *Clepsisaurus* Lea, *Centemodon* Lea, or *Omosaurus* Leidy, is difficult to determine. These fossils are on masses of rock, too large for removal; they comprise *vertebra*, *ribs*, *tibia*, *femur*, *coracoid*, and other bones. I will describe the bones on the masses of rocks as I obtained them, viz.:

On No. 1. Concave vertebra 2½ *inches* in diameter with spinous process 6 inches long from centre of vertebra, and other bones.

On No. 2. Part of a very large bone 3½ inches long measuring across largest end 2½ in. and at smallest 2 in. with ribs, vertebra, and other bones.

On No. 3. Fine large bone 7 inches long, 2 in. diameter at smallest end, 3¼ inches over condyles. This bone has a *large medullary cavity.* Another bone on same rock is 10½ inches long, diameter at smallest end 1½ inches: a coracoid on same stone, with other parts. Other pieces exhibit ribs, vertebra, spinous process, teeth, coprolites, some with scales and bones of Ganoid fishes in them.

Equisetum calumnare! very fine specimens 15 to 16 inches in circumference and 7 in. long, the first time it has been noticed this side of Richmond (Va.) Coal Basin.

Pterozamites longifolius like those figured in Emmons's North Carolina Report. *Gymnocaulus alternatus* Em. *Fir Cones*, 3 in. long, 1 inch wide, two species of *Estheria*, *Cypris*, *Myacites*, *Pennsylvanicus* Conrad, and a lot of undetermined fossils—some very like *Crustaceans* and *possibly* remains of *Insects.*

2. *Upheaval of the sea and inundation at Kahului and Maliko, Maui, Sandwich Islands.*—A sudden tide wave occurred on the 2d of December, 1860, along the coast of East Maui, lying between Kalului and Maliko, and extending farther on toward the Hana district, a distance along the shore of some twenty-five miles. The wave, of which there was but one on this occasion, rose about eight feet, and resembled the same phenomenon which occurred in that district some twelve or fifteen years ago, and which consisted of several waves, following each other at short intervals. It took place during the night, and created some consternation among the natives. No serious damage was done, though two or three native huts at Maliko are reported as having been removed from their foundations, and a wharf or staging erected by the new sugar company at the same harbor were carried inland and left high and dry, when the water receded. These phenomena are no doubt caused by the volcano of Mauna Loa, which by a submarine eruption creates a disturbance in the sea.—*Pacific Advertiser, Honolulu, Dec.* 12, 1860.

We look with interest to the tidal register of the Coast Survey to learn whether this vibration was felt along the Pacific Coast of this Continent as in the more remarkable case of the great upheaval at Jeddo in 1854.

3. *Dr. Cooper's reply to Gov. Stevens's charge of Plagiarism in* vol. xxx, p. 302.—We have received a long letter from Dr. Cooper dated at San Francisco, Nov. 20, 1860, in which he reviews the charges of Gov. Stevens with more detail than the public interest in the controversy warrants, or than our space can admit.

Dr. Cooper's manly explanation of the origin of Gov. Stevens's complaints which we give below, and the laudable spirit which characterizes his communication, at once relieves this gentleman from any suspicion of intentional injustice to Gov. Stevens, and renders the publication of other details needless.

Dr. Cooper states that he assisted Gov. Stevens largely in the preparation of the Chapter on Meteorology. While he disclaims any intention of appropriating any of Gov. Stevens's labors, he adds that "nothing but the accident of his arriving at Washington (in July 1859) after the work was printed, had prevented his giving credit to Gov. S. for the authorship of the Chapter on Meteorology."

"I have offered," says Dr. Cooper, "to Gov. Stevens, in a letter, (which he did not wait to receive before publishing his reclamation for my 'plagiarism,') to go the expense of an extra title page to the Chapter on Meteorology, without mention of my own name. This can be sent to each owner of a copy to be pasted in before the Chapter, and will give credit more conspicuously, than if his name was in the general title page of the book."

"I have offered to consider any plan which he may esteem preferable."

As Dr. Cooper also proposes, "to refer to the Editors of this Journal the question of the propriety of his making farther acknowledgments or concessions"—we have only to say, while we believe that Gov. Stevens will be satisfied with the disclaimers and explanations of Drs. Cooper and Suckley, we cannot doubt that it would have been more satisfactory to all parties had the general title page of the "Contributions to the Natural History of Washington Territory," stated in substance "that these observations were made in connection with the Expedition to survey routes for a Pacific Railroad from the Mississippi River to the Pacific Ocean near the 47th and 49th parallels of N. latitude, under command of Gov. I. I. Stevens."

4. *Fulgurites or Lightning tubes.*—Dr. Hitchcock informs us (Nov. 20, 1860) that he has received from Dr. A. Cobb, of Montague, Mass., "specimens, which appeared to be some kind of slag, more or less tubular, with the cavities glazed on the inside and rough on the outside; looking externally somewhat like branched coral; the branches nearly an inch in diameter and flattened. In short, it was obviously fine sand which had been fused by heat on the inside of the mass, so as to form a thin pellicle of brown glass. The specimens were found at Northfield Farms, in Massachusetts, on what was supposed to be an old Indian camping ground, or battle-ground." They are obviously fulgurites.

5. *New Meteorites from Hindostan.*—Two meteoric stones fell on the 28th of Feb., 1857, near the village of Parnallee in Southern Hindostan, about noon from a cloudless sky—one of them weighing about 37 pounds, has reached this country as a gift from Rev. H. S. Taylor, to whom we owe the history of the fall, to the Cabinet of Western Reserve College, Ohio. A description of this stone will appear in our next.

6. *Results of a Scientific Mission to India and High Asia* 1854 *to* 1858, *by Hermann, Adolphe and Robert de Schlagintweit.*—We have received the Index to vol. i. of this important work, together with four large maps, of which No. 1 shows the routes taken by the Brothers Schlagintweit through India and High Asia; No. 2 shows the lines of equal magnetic declination; No. 3 the lines of equal magnetic dip; and No. 4 the lines of equal magnetic intensity throughout India as far north as lat. 40°. This work is published in quarto in the best style by Brockhaus of Leipsic, and forms an important contribution to our knowledge of terrestrial magnetism. When the entire work has been received we propose to give a full account of its contents. The maps are very perfect specimens of cartography and chromatic printing.

7. "*The Botanical Society of Canada*," an institution of great promise, was established at Kingston, Canada West, on the 7th of December last, at a meeting called for the purpose at Queen's College, the Rev. Principal Leitch in the chair. Principal Leitch is the President of the Society, and Prof. George Lawson, Secretary. We have read with great interest the report of one or two meetings of this Society, at which valuable papers were read, and we learn that arrangements are made for the publication of the botanical papers of permanent interest which are read before the Society.

8. *Assinniboine and Saskatchewan Exploring Expedition.*—Prof. Hind's interesting narrative of his explorations in this region (see vol. xxx, p. 288,) is about to be published by Longmans in London, in an 8vo, the neatly reduced maps for which edition have reached us.

9. *The American Association for the Advancement of Science.*—This body adjourned to meet at Nashville, Tennessee in April next. The Local Committee had fixed on the 17th of April, the third Wednesday, as the day of meeting. We learn however that there is a possibility the Standing Committee, who have charge of the affairs of the Association *ad interim*, acting with the Permanent Secretary, will advise a postponement of this meeting for one year, owing to the disturbed condition of public affairs.

Obituary.

10. Major John LeConte.—This well known naturalist died at Philadelphia, on the 21st of November, 1860, aged 77, having been born at Shrewsbury. N. J., Feb. 22, 1784. He entered the corps of U. S. Engineers in 1818, and derived his title of Major from that service. His chief contributions to science have been in botany and zoology. Dr. Coates has been requested to preface a notice of his life for the Am. Phil. Society.

11. Charles W. Hackley, Professor of Mathematics and Astronomy, in Columbia College, died in New York, Jan. 11, 1861, of a nervous fever. He was born in Herkimer Co., N. Y., in 1809, entered the U. S. Military Academy at West Point in 1825, and was Assistant Prof. of Mathematics there from 1829 to 1832. Leaving military life he studied theology and entered Episcopal orders in 1835. He was Professor of Mathematics in the University of New York from 1833 to 1839, when he was elected to the Presidency of Jefferson College, in Mississippi. From the year 1843 up to the time of his death he filled the chair of Mathematics in Columbia College, N. Y. He was the author of several elementary scientific works —a "Treatise on Algebra," published in 1846, an "Elementary Course

on Geometry," which appeared in 1847, and "Elements of Trigonometry, with their Practical Application to Navigation and Nautical Astronomy."

Book Notices.—

12. *Illustrated Catalogue of Philosophical Apparatus;* by Edward S. Ritchie, No. 313 Washington st., Boston, 1860, pp. 84, 8vo. Also *Ritchie's Catalogue of School Apparatus.*—Mr. Ritchie's catalogues attest the neatness, skill and good taste with which his apparatus is prepared. The Illustrated Catalogue enumerates many pieces of physical apparatus not heretofore included in the catalogue of American instrument makers. Teachers will be agreeably surprised by an examination of the Catalogue of School Apparatus to find how much may be done for a very modest sum in illustrating the principles of physics.

13. *Education: intellectual, moral, physical;* by Herbert Spencer, Author of "Social States," etc., etc. New York, D. Appleton & Co., 1861. 8vo, pp. 283.—We have examined this book sufficiently to be able to say that the style of it is vigorous and the matter condensed without the sacrifice of clearness. It is composed of four essays, bearing the following titles: I. What knowledge is most worth? II. Intellectual Education. III. Moral Education. IV. Physical Education. These were originally published in the English Reviews. The discussions are able and suggestive; and will, in one particular at least, be likely to gratify the students of nature, inasmuch as they warmly insist on the superior advantages of science over languages, in the culture of youth. The author belongs to the school of Compte, and the deficiencies of his treatise, especially under the topic of moral training, are to be ascribed to this circumstance. On the whole, however, while the attention of the reader is strongly drawn to the profound importance of the general subject of education, the views taken in the book are commonly well sustained.

We observe also that it is proposed to issue by subscription, Mr. Spencer's System of Philosophy, comprising First Principles, 1 vol. The Principles of Biology, 2 vols. The Principles of Psychology, 2 vols. The Principles of Sociology, 3 vols. The Principles of Morality, 2 vols. Messrs. D. Appleton & Co., 443 and 445 Broadway, N. Y., are the American publishers.

VI. BOOKS RECEIVED.

The Report of the British Association, Aberdeen, 1859. (From the Association.) London, 1860. 8vo, pp. 310 and 312.

Magnetical and Meteorological Observations. St. Helena. Vol. II. 1844–49. Printed by the British Government under the superintendence of Maj. Gen. Edward Sabine. London: Longmans. 4to, pp. 526. Presented by the British Government.

Occasional papers on the Theory of Glaciers by James D. Forbes, D.C.L., F.R.S. Edinburgh: Black. 1859. 8vo, pp. 278.

Siluria: The history of the Oldest Fossiliferous Rocks, &c., by Sir Roderick Impey Murchison, &c., &c. Third edition (including "*The Silurian System.*") London: John Murray. 1859. 8vo, pp. 592, 41 plates. [The two last valuable works by the carelessness of a forwarding agent reached us *two years* after date.]

Thirteenth Annual Report of the Regents of the University of the State of New York, on the Condition of the State Cabinet of Natural History. Made to the Senate, April 10, 1860. Albany, 1860. (See notice on p. 292.)

The Manufacture of Vinegar, its Theory and Practice with especial reference to the Quick Process; by C. M. Wetherill, Ph.D., M.D. Philadelphia: Lindsay & Blakiston. 1860. 12mo, pp. 300. (A review prepared for this No. will appear in our next.)

Manual of Geology: designed for the use of Colleges and Academies; by EBENEZER EMMONS. Illustrated by numerous engravings. Philadelphia: Sawyer, Barnes & Co. 1860. 12mo, pp. 290.

Patent Office Report (Agriculture), 1859. 8vo, pp. 589. Washington.

Coal, Petroleum, and other Distilled Oils; by ABRAHAM GESSNER, M.D., F.G.S. 8vo, pp. 134. Baillière Brothers, N. Y. 1861. (See notice in No. 91, p. 147.)

Geological Report of the Country along the line of the Southwestern Branch of the Pacific Railroad in Missouri; by G. C. SWALLOW, State Geologist. St. Louis, 1859. 8vo, pp. 93.

History, Theory, and Practice of the Electric Telegraph; by GEO. B. PRESCOTT. Boston: Ticknor & Fields. 1860. 12mo, pp. 468.

Annual Report of the Board of Regents of the SMITHSONIAN INSTITUTION, showing the operations, &c., for 1859. Washington, 1860. 8vo, pp. 450.

Warren's Descriptive Geometry, Orthographic Projections; by EDWARD WARREN, C. E. New York: John Wiley. 1860. 8vo, pp. 412. (See notice in No. 91, p. 148.)

JAHRESBERICHT der Chemie Physik, Mineralogie und Geologie für 1859. Giessen, 1860. 8vo, pp. 903.

Geological Survey of Canada. Reports of Progress for the year 1858. Montreal, 1859. 8vo, pp. 263. (See notice in No. 91, p. 122.)

Geological Survey of New York. Palæontology: Vol. III. Containing Descriptions and Figures of the Organic Remains of the Lower Helderberg Group and Oriskany Sandstone, 1855–1859. By JAMES HALL. Part I: Text. Albany: printed by C. Van Benthuysen. 1859. 4to, pp. 532.

Memoirs of the Literary and Philosophical Society of Manchester. Vol. XV. (*Second Series.*) London: H. Baillière. 1860. 8vo, pp. 316.

Philosophical Transactions of the Royal Society of London, 1850 to 1859 inclusive. 4to. From the Royal Society.

New American Cyclopedia: a Popular Dictionary of General Knowledge. Appleton & Co., N. Y. Vol. XI. 8vo, pp. 788. MAC—MOX.

NICKLÈS, J.—Les Electro-aninants et l'adhérence magnétique. 8vo, 5 planches. *Elacroix.* 2 copies.

Il Nuovo Cimento, Giornale di Fisica, Chimica, E Storea Naturale; Direttori MATTEUCCI, PIRIA, MENEGHINI. Tomo IX, X, XI. Torino, Pisa. 1859–1860.

Répertoire de Chimie Appliquée; Comptes Rendu des Applications de la Chimie en France et a l'Etranger par BARRESWIL. Tome I et II, 1859. 1860. Paris.

Répertoire de Chimie Pure; Compte Rendu des Progrès de la Chimie Pure en France et a l'Etranger par M. AD. WURTZ. Paris. Tome I et II, 1859–1860.

Der Zoologische Garten Organ für die Zoologische Gesellschaft der Dr. WEINLAND. Frankfurt *a.* M. Heft 1–12. 1860.

Polytechnisches Notizblatt. Herausgegaben und redigirt von Prof. Dr. RUD. BÖTTGER in Frankfurt *a.* M. 1860.

Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen. Afdeeling NATUURKUNDE. Tiende Deel. Amsterdam. G. Van der Post. 1860. 8vo, pp. 342.

The same, Afdeeling LETTERKUNDE. Vijfde Deel. 8vo, pp. 401. 1860.

The Natural History Review and Quarterly Journal of Science, by Profs. HARVEY, HAUGHTON, HOGAN and WRIGHT. London, 1860. 8vo.

Journal of the Academy of Natural Sciences of Philadelphia. New Series. Vol. IV, Part IV. Philadelphia, Dec., 1860. 4to, pp. 321 to 416.

First Principles; by HERBERT SPENCER. No. 1. Part I, The Unknowable. New York: D. Appleton & Co. 1860. pp. 80. (See notice on p. 304.)

Zeitschrift für Chemie und Pharmacie, correspondenzblatt, Archiv und Kritisches Journal für Chemie, &c. Von Dr. E. ERLENMEYER und Dr. G. LEWENSTEIN. Erlangen, 1860.

BROCHEURES.

Agricultural Chemistry.—

Experimental Inquiry into the Composition of some of the Animals fed and slaughtered as Human Food; by JOHN BENNET LAWES, R.R.S., F.C.S., and JOSEPH H. GILBERT, Ph.D., F.C.S., (from the PHILOSOPHICAL TRANSACTIONS, 1859). London. 4to, pp. 187:—

By the same authors—

Sheep-feeding and Manure. Part I. 1849.—Report of Experiments on the Comparative fattening qualities of different breeds of Sheep. Parts I, II, and III.—Pig feeding.—On the Equivalency of Starch and Sugar in Food.—On the Composition of Foods, in relation to Respiration and the Feeding of Animals.—Experimental Inquiry in the Composition of some of the Animals fed and slaughtered as Human Food.

On Agricultural Chemistry, especially in relation to the Mineral Theory of Baron Liebig.

Agricultural Memoirs by LAWES and GILBERT, continued.

On the amounts of, and methods of estimating, Ammonia and Nitric acid in Rain-water.

Report to the Right Hon. the Earl of Leicester, on experiments conducted by Mr. Keary, on the Growth of Wheat upon the same land for four successive years, at Holkham Park farm.

Reply to Baron Liebig's Principles of Agricultural Chemistry.

On the Growth of Wheat by the Lois Weedon system, on the Rothamsted soil; and on the combined Nitrogen in Soils.

On the Growth of Barley by different manures, continuously on the same land, and on the position of the crop in rotation.

On some points in the Composition of Wheat-grain, its products in the mill, and Bread.

Report of experiments with different manures on permanent meadow land, (with tabular appendix).

Report of experiments on the Growth of Red Clover by different manures.

Letter on the Utilization of Town Sewage.

Discourse on the Composition of the Animal portion of our food, and on its relations to Bread. (Abstract.)

On the Sewage of London.

Lectures on Agricultural Chemistry, delivered at the Smithsonian Institution, Dec. 1859, by Professor SAMUEL W. JOHNSON, of Yale College, Connecticut.

GEOLOGY.—

On the Silurian and Devonian rocks of Nova Scotia; by J. W. DAWSON, LL.D., F.G.S.

Notice of Tertiary Fossils from Labrador, Maine, &c., and Remarks on the Climate of Canada, in the newer pliocene or pleistocene period; by J. W. DAWSON.

On the Vegetable Structures in Coal; by J. W. DAWSON, LL.D., F.G.S., &c., Principal of M'Gill College, Montreal. From the Quarterly Journal of the Geological Society, Feb. 1860.

On a Terrestrial Mollusk, a Chilognathous Myriapod, and some new species of Reptiles, from the Coal formation of Nova Scotia; by J. W. DAWSON, LL.D., F.G.S., Principal of M'Gill College, Montreal.

MENEGHINI, CHEV. JOS.: Palæontologie de L'Ile de Sardigne. Supplément. 4to. Turin, 1860.

On certain theories of the formation of mountains. No. 1. E. BILLINGS, from the Canadian Naturalist and Geologist, December, 1860.

Description of New Fossils from the Palæozoic rocks of the Western States, from the Transactions of the Chicago Academy of Sciences, October 11th, 1859; contributed by J. H. MCCHESNEY. Extract No. 2.

Notice of Geological Discoveries, made by Capt. J. H. SIMPSON, Topographical Engineers, U. S. Army, in his recent Explorations across the Continent.

Descriptions of new Organic remains from the Tertiary, Cretaceous and Jurassic rocks of Nebraska; by F. B. MEEK and F. V. HAYDEN. By MEEK and ENGELMANN.

Descriptions of two new species of Carboniferous fossils, brought from Fort Belknap, Texas, by Dr. Moore; by W. M. GABB.

Descriptions of new Carboniferous fossils from Illinois and other Western States; by F. B. MEEK and A. H. WORTHEN, of the Illinois State Geological Survey.

Descriptions of New Species of Crinoidea from the Carboniferous Rocks of the Mississippi Valley; by JAMES HALL. From Jour. Boston Soc. Nat. Hist., Jan. 1861. The same in a different imprint. Abstract.

CHEMISTRY.—

Nuevo Metodo Para el Exámen de Química en el Establecimiento Cientifico de Latacunga. CARLOS CASSOLA, Profesor de Química, Ecuador, S. A.

A Manual of Qualitative Analysis; by D. K. TUTTLE, Ph.D., University of Virginia, and C. F. CHANDLER, Ph.D., Union College. Charlottesville, Va., Schenectady, N. Y. Albany, 1860.

On the Amounts of Lead contained in some Silver Coins; by CHARLES W. ELIOT and FRANK H. STORER. Proceedings of the American Academy, Sept. 11, 1860.

An Outline for the Quantitative Analysis of Urine; by HENRY ERNI, A.M., M.D., Professor of Medical Chemistry and Medical Jurisprudence in Shelby Medical College, Nashville, Tenn. Nashville, Tenn., 1860.

MINERALOGY.—

Mineralogie und Chemische Geologie. (Kopp's Jahrb., 1860.)

Recherches sur les Pseudomorphoses; par M. DELESSE.

Ermittelung Krystallographischer Constanten und des grades ihrer Zuverlässigkeit; von H. DAUBER, Assistenten am K. K. Hof-Mineralien-Cabinete. (Mit 5 Tafeln.) Wien, 1860.

Mémoire sur les Formes Cristallines et les Propriétés Optiques de la Zoïsite, de la Sillimanite et de la Wöhlérite, et Note sur une Nouvelle Disposition du Microscope Polarisant; par M. DESCLOIZEAUX.

On Tetradymite: reply to Dr. C. T. Jackson, of Boston; by F. A. GENTH.

Der Meteorit von St. Denis-Westrem im k. k. Hof-Mineralien-Cabinete; von dem w. M. W. HAIDINGER.

Die Calcutta-Meteoriten, von Shalka, Futtepore, Pegu, Assam und Segowlee im k. k. Hof-Mineralien-Cabinete; von dem w. M. W. HAIDINGER.

Der Meterorit von Shalka in Bancoorah und der Piddingtonit; von dem w. M. W. HAIDINGER.

Die Meteoriten des k. k. Hof-Mineralien-Cabinetes, am 30 Mai, 1860; W. HAIDINGER.

ZOOLOGY AND BOTANY.—

New Unionidæ of the United States and Northern Mexico. By ISAAC LEA, LL.D. 4to, 15 plates. Philadelphia, Nov., 1860.

Smithsonian Miscellaneous Collections.—Catalogue of the described Lepidoptera of North America. Prepared for the Smithsonian Institution by JOHN G. MORRIS. Washington: Smithsonian Institution, May, 1860.

Smithsonian Miscellaneous Collections.—Check Lists of the Shells of North America. Prepared for the Smithsonian Institution, by ISAAC LEA, P. P. CARPENTER, WM. STIMPSON, W. G. BINNEY, and TEMPLE PRIME. Washington, June, 1860.

Synonymy of the family Cyclades; by TEMPLE PRIME.

Catalogue of the Fishes of the Eastern Coast of North America from Greenland to Georgia; by THEODORE GILL. February, 1861.

Catalogue of the Phænogamous and Filicoid plants of Newcastle County, Delaware; by EDWARD TATNALL. Published by the Wilmington Institute. Wilmington, Del., 1860.

Catalogue of the Flowering Plants and Ferns of Ohio; by J. S. NEWBERRY, M.D. Columbus, 1860.

Additions to the Flora of Wisconsin; by T. J. HALE, University of Wisconsin.

MISCELLANEOUS.—

On Meteorology; by Professor JOSEPH LOVERING, of Harvard University.

Notes on the Apparent Universality of a principle analogous to Regelation, on the Physical Nature of Glass, and on the Probable existence of Water in a state corresponding to that of Glass; by EDWARD W. BRAYLEY, Esq., F.R.S., &c. From the Proceedings of the Royal Society, vol. x, p. 450.

On Luminosity of Meteors from Solar Reflexion; by R. P. GREG, F.G.S.

Binocular Vision, theory of Images on Transparent Media, and the Stereomonoscope; by C. J. WISTER, Jr., Germantown, Penn.

Remarks on the Aurora of August 28, 1859; by BENJAMIN V. MARSH.

Objects and Plan of an Institute of Technology, &c., proposed to be established in Boston. Boston, 1860. Prof. W. B. ROGERS.

Notice sur la vie et les travaux de P.-A. Dufrénoy, suivie d'une liste Bibliographique de ses Publications; par A. D'ARCHIAC, lue a la Société Géologique de France. Dans la Séance du 21 May, 1860.

Report on the Huacals, or Ancient Graveyards of Chiriqui. A paper read before the American Ethnological Society, by J. KING MERRIT, M.D.

Bulletin of the American Ethnological Society.—On a Stone implement from New Jersey; by Dr. JOHN C. EVANS, of Pemberton, New Jersey.

Bulletin of the Wisconsin Agricultural and Mechanical Association. Milwaukie, 1860.

The Rock Oils of Ohio; by J. S. NEWBERRY. 1859.

The Penokee Iron Range of Lake Superior, with Reports and Statistics, showing its mineral wealth and prospects; by I. A. LAPHAM. Milwaukee, 1860.

Description and Key to Nystrom's Calculator, with Practical Rules and Examples for using the same; by J. W. NYSTROM.

Report on the condition of the Niagara Railway Suspension Bridge; by JOHN A. ROEBLING, Civil Engineer. 1860.

Catalogue des Principaux appareils d'Acoustique qui se fabrequent chez RUDOLPH KŒNIG, a Paris, Place du Lycée Louis-le-Grand, 5. 1859.

Science the true basis of Education.—An Address before the College of California, at Oakland, June 14th, 1860; by CHAS. ARTHTR ELY. San Francisco, 1860.

Modern Warfare: its Science and Art; by Capt. E. B. HUNT, Corps of Engineers, U. S. A. Read before the American Association for the Advancement of Science, at Newport, R. I., August 4, 1860. From "the New Englander," Nov., 1860.

Denkschriften der Naturwissenschaftlichen Gesellschaft Isis zu Dresden. Dresden, 1860.

Natural Selection not inconsistent with Natural Theology: A Free Examination of Darwin's Treatise on the Origin of Species, and of its American reviewers; by ASA GRAY, M.D., Fisher Professor of Natural History in Harvard University. Cambridge, 1861.

Illustrated Catalogue of Chemical Apparatus exhibited in the Educational Department of the Museum of Science and Art, South Kensington. I. I. Griffin. London, 1861.

A Notice of the origin, progress, and present condition of the Academy of Natural Sciences of Philadelphia; by W. S. W. RUSCHENBERGER, M.D., Surgeon U. S. Navy. Second edition, revised and corrected up to January 1, 1860, by the Author. Philadelphia, 1860.

Proceedings of the Essex Institute. Vol. II, Part 2. 1857 to 1859. Salem, 1860.

Charter, Constitution, By-Laws and List of Officers of the Wisconsin Natural History Association. Milwaukee, 1860.

Das Königliche Mineralogische Museum in Dresden geschildert auf Hohe Veranlassung von H. B. GEINITZ. Dresden, 1858.

VII. PROCEEDINGS OF SOCIETIES.

JOURNAL OF THE ACAD. NAT. SCI. OF PHILADELPHIA, (continued from vol. XXX, p. 160.) Vol. IV., Part IV., (N. S.), contains (Dec. 1860) Art. XII, Description of new birds of Western Africa, in the Museum of the Academy of Natural Sciences of Philadelphia; *John Cassin.*—Art. XIII, New Unionidæ of the United States and Northern Mexico; *Isaac Lea, LL.D.*—Art. XIV, Descriptions of New Species of American Tertiary and Cretaceous Fossils; *Wm. M. Gabb.*

PROC. OF ACAD. NAT. SCI. OF PHILAD. 1860. (Continued from vol. XXX, p. 160.)—145, Plants appearing in flower, in neighborhood of Philadelphia from Feb. to May, 68 species; *Dr. Darrach.*—146, Habits of the Beaver; *Smith.*—147, Occurrence of *Physa gyrina* in cisterns and water from Artesian wells in Alabama; *Lea.*—Diminution of petrolium in Pennsylvania Oil wells; *R. E. Rogers.*—148, European species of shells off Nova Scotia; *J. R. Willis.*—Modification of Gore's ball revolving by a galvanic current; *R. E. Rogers.*—Death of B. Henry, M D., announced. —149, Habits of the black Snake; *A. H. Smith.*—149, Rock-boring Mollusca; *I. Lea.* —150, Notes on American Land shells, No. 6; *W. G. Binney.*—154, Description of new species of Pulmonata in the collection of the Smithsonian Institution; *W. G. Binney.*—A list of Shells in the State of Wisconsin; *I. A. Lapham.*—156, Contributions to American Lepidopterology, No. 4; *Brackenrige Clemens, M. D.*—174. Description of a new species of Marginella; *J. H. Redfield.*—175, Descriptions of new organic remains from the Tertiary, Cretaceous and Jurassic rocks of Nebraska; *F. B. Meek* and *F. V. Hayden.*—186, Descriptions of fourteen new species of Schizostomæ, Anculosæ and Lithasiæ; *Isaac Lea.*—188, Catalogue of Birds from the Isthmus of Darien, collected by Lt. N. Michler, U. S. Top. Eng., with notes and descriptions of new species; *John Cassin.*—197, Descriptions of new species of Cretaceous Fossils from S. America in the collection of the Academy; *W. M. Gabb.*— 199, Catalogue of plants in flower during the month of May near Philadelphia; *Dr. Darrach.*—201, Death of G. W. Carpenter noticed by resolution.—202, Remarks on Combustion; *R. E. Rogers.*—On the identity of Ammonites Texanus, ROEMER, and A. vespertinus, MORTON; *W. B. Gabb.*—203, Contributions to American Lepidopterology, No. 5; *Brackenridge Clemens, M. D.*—221, Hemiptera of the North Pacific Exploring Expedition under Com'rs Rodgers and Ringgold; *P. R. Uhler.*—231, Notes on Shells; *T. A. Conrad.*—233, The "Cutting Ant" of Texas (MYRMICA (ATTA) TEXANA); *S. B. Buckley.*—236, Contributions to the Carboniferous Flora of the United States; *H. C. Wood, Jr.*—241, Catalogue of the Colubridæ in the Museum of the Academy of Nat. Sci. of Philad., with notes and descriptions of new species, Part 2; *E. D. Cope.*—267, Synonymy of the Cyclades, a family of Acephalous Mollusca, Part 1, family CYCLAS 176 Nos., SPHÆRIUM 93 Nos.; *Temple Prime.*—302, List of plants in flower near Philadelphia in June, 1860; *Dr. Darrach.* —305, Descriptions of two new species of UNIONES from Georgia; three from Mexico; some Unionidæ from the United States; six from Alabama; and three exotic species; *I. Lea.*—308, Descriptions of new Fossil Remains collected in Nebraska and Utah, by the Expl. Expeditions under command of Capt. J. H Simpson, of U. S. Top. Engineers [in advance of the official Report by sanction of Sec'y Floyd]; *F. B. Meek.* 315, Notes on the Coleoptera found at Fort Simpson, Mackenzie River, with remarks on Northern species; *J. L. LeConte.*—321, Synopsis of the Scaphidiidæ of U. States; *J. L. LeConte.*—324, Description of a new species of Cephalopod, from the Eocene of Texas; *W. M. Gabb.*—325, Descriptions of new species of American Freshwater Fishes; *C. C. Abbott.*—328, Descriptions of new species of North American Serpents in the Museum of the Smithsonian Institution, Washington; *Robert Kennicott.*—339, Notes and descriptions of new and little known species

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